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10/800,061	03/12/2004	Takahiko Yamasaki	36549	8441

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EXAMINER

LEUNG, PHILIP H

ART UNIT

PAPER NUMBER

3742

DATE MAILED: 04/10/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

10/800,061

Applicant(s)

YAMASAKI ET AL.

Examiner

Philip H. Leung

Art Unit

3742

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 23 January 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1 and 3-21 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 19 is/are allowed.
- 6) ☒ Claim(s) 1, 3-18, 20 and 21 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_.

- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

### DETAILED ACTION

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claim 11 is rejected under 35 U.S.C. 102(a) and 102(e) as being anticipated by Hayakawa (WO 03/077604) (newly cited).

Hayakawa shows a high frequency heating apparatus for heating a thing to be heated (M), comprising: a high frequency generating portion (13); a heating chamber (11) for accommodating the thing to be heated; a steam generating portion (15) for generating steam (S) in the heating chamber and a steam delivery means for guiding the generated steam from inside the heating chamber to outside the heating chamber through a steam delivery path back into the heating chamber (as shown in Figures 7 and 16, the steam generated in the heating chamber is drawn through the intake ventilation holes 29 by the fan 17 outside the heating chamber and back to the heating chamber 11 through the blast ventilation holes 31 of the partition plate 27; see page 33, line 5 – page 34, line 17).

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3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 1, 8, 9, 12-15, 20 and 21 and are rejected under 35 U.S.C. 103(a) as being obvious over Hayakawa (WO 03/077604), in view of Yoneno et al (US 5,525,782) (previously cited).

Hayakawa shows a high frequency heating apparatus for heating a thing (M) to be heated comprising: a high frequency generating portion (13); a heating chamber (11) for accommodating the thing to be heated; a steam generating portion (15) for generating steam (S) in the heating chamber located in the lower back portion of the heating chamber (as shown in Figures 1, 7-9 and 16 and pages 27-41). Therefore, Hayakawa shows every feature as claimed except for the use of a partition plate which serves to mount the thing to be heated thereon and is provided to be upward removable apart from a bottom face of the heating chamber a predetermined interval. However, it is pointed out that the use of partition plates in a cooking chamber is a routine and well known feature in the art of ovens. Anyway, Yoneno shows a high frequency heating apparatus for heating a thing to be heated, comprising: a high frequency generating portion 32; a heating chamber 2 for accommodating the thing to be heated; a steam supply portion 40 for supplying steam into the heating chamber; and a partition plate which serves to mount the thing 1 to be heated thereon and is provided to be upward removable apart from a bottom face of the heating chamber at a predetermined interval (shown in Figures 4-7), thereby dividing a space in the heating chamber, wherein at least one of a high frequency and

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steam generating portion is supplied to the heating chamber and the steam is supplied into an upper space (discharge port 8, 17) positioned above the partition plate (see Figures 4-14 and 21 and col. 7, line 12 – col. 16, line 4). It would have been obvious to an ordinary skill in the art at the time of invention to modify Hayakawa to use partition shelves in the heating chamber for dividing the chamber into sections in order to support a plurality of food items to be microwave heated and/or steam heated at the same time for more heating efficiency and result, in view of the teaching of Yoneno. In regard to claims 8 and 9, heater 3 of Yoneno or heater element 10 of Kikuchi is the claimed preheating means including an upper heater provided in an upper part of the heating chamber. In regard to claim 11, see Figures 5, 6, 14 and 21 of Yoneno. In regard to claim 12, see Figures 4-6 of Yoneno. In regard to claim 15, element 33 in Figures 1 and 8 of Hayakawa is the claimed distribution means. In regard to claim 20, Hayakawa also shows the claimed cover 41 for the pan 35 (see Figures 10A and 10B).

5. Claims 3, 4, 6 and 7 are rejected under 35 U.S.C. 103(a) as being obvious over Hayakawa (WO 03/077604), in view of Yoneno et al (US 5,525,782), as applied to claims 1, 8, 9, 12-15, 20 and 21 above, and further in view of Kawada (JP 54-10460) (previously cited).

Hayakawa combined with Yoneno shows every feature as claimed except for the material of the partition plate. Kawada shows a microwave oven with a steam generating portion on the bottom of the heating chamber below a metal partition part 21 and 22 as shown in Figure 3. It would have been obvious to an ordinary skill in the art at the time of invention to further modify Hayakawa combined with Yoneno to locate the steam generating portion on the bottom of the cooking chamber below a metallic partition plate so that steam can rise up the plate for

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direct steam heating the food while preventing the microwave from going into the water heating components, in view of the teaching of Kawada.

6. Claims 5, 10 and 16-18 are rejected under 35 U.S.C. 103(a) as being obvious over Hayakawa (WO 03/077604), in view of Yoneno et al (US 5,525,782), as applied to claims 1, 8, 9, 12-15, 20 and 21 above, and further in view of Kurita (US 6,232,587) (previously cited).

Hayakawa combined with Yoneno shows every feature as claimed except for the use of a high frequency material for forming the partition plate. Kurita shows a microwave oven with steam generating portion and also partition plates 28a and 28b of a microwave absorbing material for generating heat in response to the microwave generation in the heating chamber to act as a preheating means to increase the temperature in the heating chamber (see Figures 3 and 7 and col. 5, lines 41-59 and col. 7, lines 34-58). To form the food supporting partition plate with the same material would have been obvious to an ordinary skill artisan as this would heat the food more efficiently because of direct food contact. It would have been obvious to an ordinary skill in the art at the time of invention to modify Hayakawa combined with Yoneno to use a microwave absorbing material to form the partition plate as the regenerating plates for preheating the oven for more efficient heating result, in view of the teaching of Kurita. In regard to claims 16-18, the exact heating steps would have been a matter of engineering expediencies depending on the material of food and type of cooking desired once it is taught to use a preheating step by Kurita (see Figures 10 and 11 and col. 7, line 32 – col. 9, line 67).

7. Claim 19 is allowed.

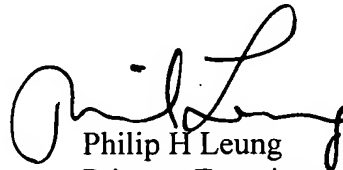
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8. Applicant's arguments filed 1-23-2006 have been considered but are moot in view of the new ground(s) of rejection.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Philip H Leung whose telephone number is (571) 272-4782.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Robin Evans can be reached on (571) 472-4777. The fax phone number for the organization where this application or proceeding is assigned is (571) 273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

  
Philip H Leung  
Primary Examiner  
Art Unit 3742

P.Leung/pl  
3-31-2006

<b>Notice of References Cited</b>	Application/Control No. 10/800,061	Applicant(s)/Patent Under Reexamination YAMASAKI ET AL.	
	Examiner Philip H. Leung	Art Unit 3742	Page 1 of 1

**U.S. PATENT DOCUMENTS**

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
	A	US-			
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

**FOREIGN PATENT DOCUMENTS**

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N	WO 03/077604 A1	09-2003	PCT	Hayakawa	H05B 6/80
	O					
	P					
	Q					
	R					
	S					
	T					

**NON-PATENT DOCUMENTS**

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

\*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)  
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.



**(57) Abstract:** A high-frequency heating apparatus with a steam generating function, which heat-treats a to-be-heated object by supplying at least high-frequency waves or steam to a heating chamber 11 that accommodates the object. This high-frequency heating apparatus has a high frequency wave generating portion 13, a steam generating portion 15 for generating steam in the heating chamber 11, and a circulating fan 17 for agitating air in the heating chamber 11. Moreover, the high-frequency heating apparatus has a chamber air heater 19 for heating air circulating in the heating chamber 11. The steam generating portion 15 generates steam by heating an evaporating dish 35 that has a water storing recess.

WO 03/077604 A1



**Published:**

— with international search report

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## DESCRIPTION

## HIGH FREQUENCY HEATING APPARATUS WITH STEAM GENERATING FUNCTION

Technical Field

5       The present invention relates to a high-frequency heating apparatus with a steam generating function, which is adapted to heat-treat an object by combining high-frequency heating and stream-heating.

Background Art

10       Conventional high-frequency heating apparatuses are a microwave oven having a high-frequency generator for heating, and a combination oven to which a convection heater for generating hot air in this microwave oven is added. Further, a steamer for heating an object by introducing steam into a heating chamber,  
15       and a steam convection oven, in which a convection heater is added to a steamer, are utilized as cooking apparatuses.

      When food is cooked by the cooking apparatus, the cooking apparatus is controlled to make the finished state of the food the best condition. That is, cooking performed by combining  
20       a high-frequency heating technique with a hot-air heating technique, and cooking performed by combining a steam heating technique with a hot-air heating technique are controlled by the steam convection oven. However, the cooking performed by combining the high-frequency heating technique and the steam

heating technique troubles a user to transfer the heated food between separate cooking apparatus each used for heat-treating according to a corresponding one of these techniques. There has been developed a cooking apparatus enabled to achieve by  
5 itself high-frequency heating, steam heating, and electric heating so as to resolve such inconvenience. This conventional cooking apparatus is disclosed in, for example, JP-A-54-115448.

However, according to the configuration of the conventional cooking apparatus disclosed in JP-A-54-115448, a vaporizing  
10 chamber for generating heating steam is embedded in a lower portion of the heating chamber, and adapted to be always supplied with water from a water storage tank maintained at a constant water level. Therefore, it is difficult to perform a daily work of cleaning around the heating chamber. Especially, in the  
15 vaporizing chamber, during the process of generating steam, calcium and magnesium contained in water content are condensed, deposited and fixed onto the bottom portion of the vaporizing chamber and in a pipe to thereby reduce an amount of generated steam. Consequently, the conventional cooking apparatus has  
20 a problem that the environment of the heating chamber is so unsanitary that the propagation of fungus easily occurs.

Further, although a method of generating steam by using a heating means, such as a boiler, disposed outside the heating chamber and supplying the steam generated therein to the heating

chamber is considered as a way of introducing steam into the heating chamber, troubles, such as propagation of saprophytes, breakage due to freeze-up, and contamination by foreign material owing to rust, occur in a pipe for introducing steam. Moreover, 5 the heating means are usually difficult to disassemble and clean. Therefore, it is difficult for a cooking apparatus, which treats food and needs a lot of attention thereto, to employ the method of externally introducing steam.

Furthermore, although it is usual that a temperature sensor, 10 such as an infrared ray sensor, for measuring the temperature of an object to be heated is provided in a cooking apparatus, the infrared ray sensor measures the temperature of suspended steam particles, which are present between the sensor and the object, instead of the temperature of the object. Thus, the 15 temperature of the object cannot be measured. Then, a heating control adapted to operate according to a result of detection of the temperature, which is performed by the infrared ray sensor, does not normally operate. Consequently, troubles, for instance, underheating or overheating occur. Especially, in 20 the case of following a sequential procedure for performing automatic cooking, even when underheating occurs, control advances to the next step without compensation. Thus, the conventional cooking apparatus cannot deal with the underheating problem by simply performing reheating or radiational cooling.

Consequently, the cooking may results in failure.

Further, the conventional cooking apparatus has another problem that this apparatus cannot necessarily heat the object by using a heating pattern, which has high heating efficiency, according to the kind of the object and to the temperature conditions thereof in the case where the object is a frozen food or a chilled food, and that thus, a long heating time is necessary.

#### Disclosure of Invention

The invention is accomplished in view of the aforementioned circumstances. Accordingly, an object of the invention is to provide a high-frequency heating apparatus with a steam generating function, which is enabled to easily clean a steam generating portion, to always maintain the steam generating portion in a sanitary condition, to perform proper heating treatment by accurately measuring the temperature of a to-be-heated object, and to enhance the heating efficiency thereof.

To achieve the foregoing object, according to an aspect of the invention, there is provided a high-frequency heating apparatus with a steam generating function, which heat-treats an object by supplying at least high-frequency waves or steam to a heating chamber that accommodates the object. This high-frequency heating apparatus comprises a high frequency wave generating portion, a steam generating portion for generating

steam in the heating chamber, and a circulating fan for agitating air in the heating chamber.

This high-frequency heating apparatus with a steam generating function according to the invention is adapted to  
5 generate steam in the heating chamber. Thus, steam can be quickly supplied into the heating chamber. Thus, the efficiency in generating steam can be enhanced. Further, because the steam generating portion is present in the heating chamber, the cleaning of the steam generating portion can be easily performed  
10 concurrently with the cleaning of the inside of the heating chamber. Thus, the internal environment of the heating chamber can be always maintained in a sanitary condition. Furthermore, because air of the heating chamber is circulated and agitated by the circulating fan, steam can be uniformly circulated all  
15 around the heating chamber, especially, when the steam heating is performed. Thus, the heating efficiency in heating the object can be enhanced. Moreover, steam can be circulated all over the entire heating chamber without being retained.

Consequently, the accuracy of measurement of the temperature  
20 of the object, which is performed by, for instance, the infrared ray sensor, can be improved. Thus, proper heating treatment can be performed. Further, both the high frequency heating and the steam heating can be concurrently performed as the heating method. Alternatively, one of the high frequency heating and

the steam heating can be individually performed. Alternatively, both the high frequency heating and the steam heating can be performed in a predetermined order. These ways of performing the heating method can be freely chosen and performed. Thus, 5 an appropriate cooking method can be selected according to the kind of food, and to which of a frozen food and a chilled food the object is. Especially, in the case of employing both the high frequency heating and the steam heating, the rate of rise of temperature can be increased. Thus, quick and efficient 10 cooking is enabled.

According to the second aspect of the invention, the high-frequency heating apparatus with a steam generating function further comprises a chamber air heater for heating air that circulates in the heating chamber.

15 The second high-frequency heating apparatus of the invention with a steam generating function is adapted so that air circulating in the heating chamber is heated by the chamber air heater. Thus, the temperature of steam can be freely raised. Efficient rise of the temperature of the object is realized owing 20 to the overheated steam by raising the temperature of the steam. Moreover, the rise of the temperature of the steam enables the high-temperature steam to brown the object. Furthermore, when the object is a frozen food, the defrosting of the object can be more efficiently performed.



According to the third aspect of the invention, in the high-frequency heating apparatus with a steam generating function, the steam generating portion has an evaporating dish that is provided in the heating chamber and that has a water storing recess adapted generate steam by being heated.

The third high-frequency heating apparatus with a steam generating function according to the invention is adapted so that the evaporating dish is disposed in the heating chamber, and that steam is generated by heating water stored in the water storing recess of the evaporating dish. Thus, the cleaning of a part generating steam can be easily performed simultaneously with the cleaning of the inside of the heating chamber. That is, this means that the internal environment of the heating chamber can be always maintained in a sanitary condition because of the fact that although calcium and magnesium contained in water content are sometimes condensed in the process of generating steam and deposited and fixed onto the bottom portion of the evaporating dish, the cleaning of such a part can be easily completed only by removing substances having adhered to the surface of the evaporating dish.

According to fourth aspect of the invention, a high-frequency heating apparatus with a steam generating function, which heat-treats an object by supplying at least high-frequency waves or steam to a heating chamber that

accommodates the object. The fourth high-frequency heating apparatus comprises a high frequency wave generating portion, and a steam generating portion, which is provided in the heating chamber, for generating steam from an evaporating dish that has  
5 a water storing recess adapted to generate steam by being heated.

The fourth high-frequency heating apparatus with a steam generating function is adapted so that steam is generated from the evaporating dish that is provided in the heating chamber. Thus, the steam is directly supplied into the heating chamber.  
10 Moreover, the cleaning of the steam generating portion can be easily performed. Consequently, the environment around the heating chamber can be always maintained in a sanitary condition. Furthermore, a heating method obtained by combining the high frequency heating technique with the steam heating technique  
15 can be easily realized.

According to the fifth aspect of the invention, the high-frequency heating apparatus with a steam generating function, the evaporating dish is disposed on a back-side bottom face, which is on the opposite side of an object outlet of the  
20 heating chamber, from which the object is taken out.

The fifth high-frequency heating apparatus with a steam generating function according to the invention is adapted so that the evaporating dish is disposed on the back-side bottom face, which is on the opposite side of the object outlet of the

heating chamber. Thus, the evaporating dish is not an obstacle to the taking-out of the object. Further, even when the evaporating dish is at a high temperature, there is no fear that a user's hand touches the evaporating dish when the user takes  
5 the object into and out of the heating apparatus. Consequently, the safety of the heating apparatus can be improved.

According to the sixth aspect of the invention, the high-frequency heating apparatus with a steam generating function according to the invention, the evaporating dish is  
10 disposed on the bottom face along one of side wall surfaces of the heating chamber.

In the case of the sixth high-frequency heating apparatus with a steam generating function according to the invention, steam can be efficiently supplied from the evaporating dish to  
15 the inside of the heating apparatus by disposing the evaporating dish on the bottom face along one of side wall surfaces of the heating chamber.

According to seventh aspect of the invention, the high-frequency heating apparatuses with a steam generating  
20 function according to the invention, the evaporating dish is disposed at a place at which the top face of the evaporating dish is at a predetermined height above the bottom face of the heating chamber.

The seventh high-frequency heating apparatus with a steam

generating function can prevent liquid, such as juice oozed from the object to the bottom face of the heating chamber, from flowing into the evaporating dish through the bottom face of the heating chamber. Thus, the evaporating dish can be maintained in a  
5 sanitary condition.

According to the eighth aspect of the invention, the high-frequency heating apparatuses with a steam generating function further comprises an infrared ray sensor for measuring the temperature in the heating chamber. In the eighth  
10 high-frequency heating apparatus, the evaporating dish is disposed at a place that is substantially outside a temperature measurement range in which the sensor measures the temperature.

The eighth high-frequency heating apparatus with a steam generating function can measure the temperature in the heating  
15 chamber with good accuracy by using the infrared ray sensor without erroneously detecting the high-temperature evaporating dish.

According to ninth aspect of the invention, the high-frequency heating apparatuses with a steam generating  
20 function, the evaporating dish is disposed in such a manner as to be able to be detached from the heating chamber.

In the case of the ninth high-frequency heating apparatus with a steam generating function according to the invention, the evaporating dish is disposed in such a manner as to be able

to be detached from the heating chamber. Thus, the evaporating dish can be cleaned by being taken out of the heating chamber. This facilitates the cleaning of the evaporating dish. Moreover, the replacement of the evaporating dish can be easily performed.

5 Consequently, the use of evaporating dishes of different sizes is enabled.

According to the tenth aspect of the invention, the high-frequency heating apparatuses with a steam generating function, the evaporating dish has tapered portions respectively  
10 provided at both end portions thereof so that the water storing recess gradually becomes shallower along a longitudinal direction thereof in each of the tapered portions.

In the case of the tenth high-frequency heating apparatus with a steam generating function according to the invention,  
15 water injected into the water storing recess is always stored in the central part of the evaporating dish.

According to the eleventh aspect of the invention, the high-frequency heating apparatuses with a steam generating function, the evaporating dish has a cover, which covers the  
20 top face of the evaporating dish and which has at least one aperture that opens a part of the top face thereof.

In the case of the eleventh high-frequency heating apparatus uses with a steam generating function according to the invention, the top surface of the evaporating dish for generating steam

is covered with the cover. Thus, an amount of generated steam can be controlled by the area of the aperture provided in the cover.

According to the twelfth aspect of the invention, the  
5 high-frequency heating apparatus with a steam generating function, the cover is disposed in such a manner as to be able to be detached from the evaporating dish.

In the case of the twelfth high-frequency heating apparatus with a steam generating function according to the invention,  
10 the cover is disposed in such a manner as to be able to be detached from the evaporating dish, so that the cover can be cleaned by being taken out of the heating chamber, and that the cleaning of the evaporating dish is facilitated. Moreover, the replacement of the cover with another cover provided with an  
15 aperture of a different size is facilitated. Consequently, a cover suitable for use in the heating conditions can be used.

According to the thirteenth aspect of the invention, the high-frequency heating apparatus with a steam generating function, a leg portion for forming a gap having a predetermined  
20 height the evaporating dish therefrom is provided on the bottom surface of the cover.

In the case of the thirteenth high-frequency heating apparatus with a steam generating function according to the invention, a gap having a predetermined spacing is formed between

the cover and the evaporating dish by the leg portion of the cover. Thus, when the water stored in the evaporating dish is heated, an increase in the pressure in the lower portion of the cover can be restrained by this gap. Thus, even when the  
5 temperature of the water stored in the evaporating dish rises and a bumping occurs, air causing pressure at that time is efficiently let out from the gap. This prevents water from scattering from the aperture.

According to the fourteenth aspect of the invention, the  
10 high-frequency heating apparatuses with a steam generating function, a plurality of the apertures are provided in such a way as to extend along the longitudinal direction of the cover.

In the case of the fourteenth high-frequency heating apparatus with a steam generating function, steam is uniformly  
15 supplied from the plurality of the apertures into the heating chamber.

According to the fifteenth aspect of the invention, the high-frequency heating apparatuses with a steam generating function according to the invention, the cover is made of a  
20 low-dielectric-constant material.

In the case of the fifteenth high-frequency heating apparatus with a steam generating function according to the invention, the cover is made of a low-dielectric-constant material, so that a wave loss can be suppressed to a low level.

According to the sixteenth aspect of the invention, the high-frequency heating apparatuses with a steam generating function, the steam generating portion has an evaporating dish heater for heating the evaporating dish.

5       The sixteenth high-frequency heating apparatus with a steam generating function according to the invention is adapted so that steam is generated by heating the evaporating dish by using the evaporating dish heater. Thus, the apparatus can efficiently generate steam by using the evaporating dish heater.

10       According to the seventeenth aspect of the invention, the high-frequency heating apparatus with a steam generating function, the steam generating portion has a reflector for reflecting radiation heat, which is radiated from the evaporating dish heater, to the evaporating dish.

15       The seventeenth high-frequency heating apparatus of the invention with a steam generating function according to the invention is adapted so that the radiation heat radiated from the evaporating dish heater is reflected to the evaporating dish by the reflector. Thus, heat generated by the heater can be  
20 highly efficiently utilized for generating steam.

According to the eighteenth aspect of the invention, the high-frequency heating apparatuses with a steam generating function further comprises an electromagnetic wave stirring portion for stirring high frequency waves sent from the high



frequency wave generating portion and for supplying the high frequency waves to the evaporating dish.

The eighteenth high-frequency heating apparatus with a steam generating function according to the invention is adapted  
5 so that the water stored in the evaporating dish is heated and evaporated by using the high frequency waves outputted from the high frequency wave generating portion. Thus, there is no necessity for providing a heater for generating steam. Consequently, the configuration of the apparatus can be  
10 simplified, and the cost thereof can be reduced.

According to the nineteenth aspect of the invention, the high-frequency heating apparatuses with a steam generating function further comprises a water supply portion for supplying water to the steam generating portion.

15 The nineteenth high-frequency heating apparatus with a steam generating function according to the invention is adapted so that water can be supplied to the evaporating dish by the water supply portion. Thus, regardless of the water storing capacity of the evaporating dish, a large amount of steam can  
20 be continuously generated for a long stretch of time.. Consequently, a long-term cooking to be performed by utilizing the steam heating is enabled.

According to the twentieth aspect of the invention, the high-frequency heating apparatus with a steam generating

function, the water supply portion comprises a water storage tank and a water conveyance pump for supplying a predetermined water to the evaporating dish through a water supply conduit.

In the case of the high-frequency heating apparatus with  
5 a steam generating function according to the invention, the water supply portion is constructed by comprising the water storage tank and the water conveyance pump. Thus, a necessary amount of water can be stably supplied by the water conveyance pump from the water storage tank to the evaporating dish.

10 According to the twenty-first aspect of the invention, the high-frequency heating apparatus with a steam generating function, the water supply portion has a nozzle, detachably provided at a water supply conduit end portion disposed on a wall surface of the heating chamber, for supplying water to the  
15 evaporating dish.

In the case of the twenty-first high-frequency heating apparatus with a steam generating function according to the invention, the nozzle is detachably provided thereat. Thus, even in the case that the nozzle is smeared when calcium and  
20 magnesium contained in water content are fixed thereonto, and when the juice scattered from the object adheres thereto, the nozzle can be cleaned by being removed therefrom, similarly as the evaporating dish. Moreover, the smeared nozzle can be replaced with new one. Consequently, the maintenance of the

nozzle is facilitated. Thus, the provision of the nozzle at the water supply conduit end portion, so that the cleaning of the nozzle is facilitated, and that water can be supplied to the evaporating dish at all times in a sanitary condition.

5        According to the twenty-second aspect of the invention, the high-frequency heating apparatus with a steam generating function, the nozzle is formed from a heat resistance resin material.

10       In the case of the twenty-second high-frequency heating apparatus with a steam generating function according to the invention, the nozzle is formed from the heat resistance resin material. Thus, even when the nozzle touches a food vessel in the heating chamber, the nozzle is not damaged because of the flexibility thereof. Moreover, the cleaning of the inside of  
15       the nozzle is facilitated. Furthermore, when the nozzle is manufactured as an injection mold product formed integrally with the heating chamber, the nozzles can be inexpensively supplied by mass production.

20       According to the twenty-third aspect of the invention, the high-frequency heating apparatus with a steam generating function, the heating chamber is partitioned from circulating fan chamber, in which the circulating fan is disposed, through a partition plate. Further, at least one ventilation hole for enabling the heating chamber and the circulating fan chamber

to communicate with each other is formed in the partition plate.

In the case of the twenty-third high-frequency heating apparatus with a steam generating function according to the invention, the circulating fan is accommodated in the circulating fan chamber independently provided outside the heating chamber through the partition wall. Thus, the juice, which may scatter during the cooking of the object, can be prevented from adhering to the circulating fan. Moreover, because ventilation is performed by letting air through the ventilation holes provided in the partition plate, a flow circulating through the circulating fan chamber and the heating chamber can be generated. Moreover, a steam flow generated in the heating chamber can be simplified and changed according to places, at which the ventilation holes are provided, and to the size of each of the ventilation holes.

According to the twenty-fourth aspect of the invention, the high-frequency heating apparatuses with a steam generating function, the heating chamber is partitioned from circulating fan chamber, in which the circulating fan is disposed, through a partition plate. Moreover, a ventilation hole for enabling the heating chamber and the circulating fan chamber to communicate with each other is formed in the partition plate. Furthermore, the aperture is disposed under a ventilation hole for intaking air from the heating chamber to the circulating

fan chamber, among the ventilation holes formed in the partition plate.

In the case of the twenty-fourth high-frequency heating apparatus with a steam generating function according to the invention, the top face of the evaporating dish is covered with the cover having the aperture. Thus, steam can be made to blow into the heating chamber only from this aperture. Therefore, the position of a steam outlet can be limited to a given place. Further, steam blowing out of the aperture can be once drawn into the circulating fan chamber by the circulating fan, and then blasted from a blast ventilation hole into the heating chamber by setting the position of the aperture at a place located under one ventilation hole for intaking air from the heating chamber to the circulating fan chamber, among the ventilation holes formed in the partition plate. Hence, the generated steam can be efficiently circulated in the heating chamber.

According to the twenty-fifth aspect of the invention, the high-frequency heating apparatus with a steam generating function, a ventilation hole for blasting air from the circulating fan to the heating chamber is provided at least in a lower half portion of the partition plate. Further, air in the heating chamber is circulated upwardly by the circulating fan.

The twenty-fifth high-frequency heating apparatus with a

steam generating function according to the invention is adapted so that air in the heating chamber is upwardly circulated by the circulating fan. Thus, steam, which is going to upwardly rise, is blown against the object from below. Consequently,  
5 the object can be efficiently heated.

According to the twenty-sixth aspect of the invention, the high-frequency heating apparatuses with a steam generating function, a self-cooled fan chamber partitioned from the heating chamber and the circulating fan chamber is provided in addition  
10 thereto. Further, an infrared ray sensor for detecting a temperature in the heating chamber through a detection hole provided in the wall surface of the heating chamber, and a self-cooled fan, concentrically provided with a drive shaft of the circulating fan, for cooling a drive motor are accommodated  
15 in the self-cooled fan chamber. Moreover, a pressure in a self-cooled fan chamber in the vicinity of the detection hole is maintained by rotation of the self-cooled fan at a value that is higher than a value of a pressure in a heating chamber.

The twenty-sixth high-frequency heating apparatus with a  
20 steam generating function according to the invention is adapted so that the pressure in the self-cooled fan chamber in the vicinity of the detection hole is maintained by rotation of the self-cooled fan at a value that is higher than a value of the pressure in the heating chamber. Thus, air in the heating chamber can be

prevented from entering the self-cooled fan chamber that accommodates the infrared ray sensor. Therefore, detection accuracy can be prevented from being degraded owing to adhesion of stain caused by the heating by the infrared ray sensor.

5        According to the twenty-seventh aspect of the invention, the high-frequency heating apparatuses with a steam generating function, a supply opening for blowing outside-air to an inner surface of a translucent window of an opening/closing door is provided in a side wall in the vicinity of the opening/closing  
10 door of the heating chamber.

      The twenty-seventh high-frequency heating apparatus with a steam generating function according to the invention is adapted so that outside-air is blown against the inner surface of the translucent window of the opening/closing door. Thus, fog on  
15 the translucent window, which is caused owing to the steam in the heating chamber, can be cleared. Consequently, the external visibility of the inside of the heating chamber can be enhanced. Further, the internal temperature of the heating chamber can be lowered by introducing outside-air thereinto. Thus, the  
20 steam in the heating chamber can be restrained from swiftly blowing out therefrom when the opening/closing door.

      According to the twenty-eighth aspect of the invention, the high-frequency heating apparatus with a steam generating function, the supply opening is provided in an upper part of

one of side wall faces of the heating chamber. Further, an exhaust outlet for exhausting air of the heating chamber is provided in a lower part of the other side wall surface of the heating chamber.

5 In the case of the twenty-eighth high-frequency heating apparatus with a steam generating function according to the invention, the supply opening is provided in an upper part of one of side wall faces of the heating chamber, while an exhaust outlet for exhausting air of the heating chamber is provided  
10 in a lower part of the other side wall surface of the heating chamber. Thus, air flows in such a manner as to obliquely pass over a central space of the heating chamber. Consequently, odorivectors generated from the object, which is being cooked, can be efficiently and gushingly exhausted to the outside.

15 Brief Description of Drawings

FIG. 1 is a front view illustrating a state of a high-frequency heating apparatus with a steam generating function, which is a first embodiment of the invention and put into a state in which a door thereof is opened.

20 FIG. 2 is a perspective view illustrating an evaporating dish of a steam generating portion for use in the high-frequency heating apparatus with a steam generating function shown in FIG.

1.

FIG. 3 is a perspective view illustrating an



evaporating-dish heater and a reflector of the steam generating portion.

FIG. 4 is a sectional view illustrating the steam generating portion of the apparatus.

5        FIG. 5 is a block view illustrating a control system for controlling the high-frequency heating apparatus with a steam generating function.

10       FIG. 6 is a flowchart illustrating a basic operation of the high-frequency heating apparatus with a steam generating function.

FIG. 7 is a view illustrating an operation of the high-frequency heating apparatus with a steam generating function.

15       FIG. 8 is a view illustrating a manner in which the evaporating dish is taken out of the heating chamber.

FIG. 9 is a view illustrating the positional relation between the evaporating dish and the bottom surface of the heating chamber.

20       FIG. 10 is a schematic configuration view illustrating a section of another shape of the evaporating dish, and also illustrating the evaporating-dish heater.

10.       FIG. 11 is a sectional view taken along line A-A of FIG.

FIG. 12 is a sectional view illustrating another example

of a section taken along line A-A of FIG. 10.

FIG. 13 is a schematic configuration view illustrating still another shape of the evaporation dish.

FIGS. 14A and 14B are explanatory views respectively  
5 illustrating examples of placement of the evaporating dish.

FIGS. 15A and 15B are perspective views illustrating an evaporating dish and a cover of a high-frequency heating apparatus with a steam generating function, which is a second embodiment of the invention; FIG. 15A illustrates a state of  
10 this high-frequency heating apparatus, in which the cover is not put thereon yet; and FIG. 15B illustrates another state thereof, in which the cover is put thereon.

FIG. 16 is an explanatory view illustrating a manner of circulation of steam, which is performed by the high-frequency  
15 heating apparatus with a steam generating function.

FIG. 17 is a perspective view illustrating the constitution of another cover.

FIG. 18 is an explanatory view illustrating an operation in the case of using the cover shown in FIG. 17.

20 FIG. 19 is a side view illustrating a modification using a sirocco fan.

FIG. 20 is a side view illustrating a primary part of a high-frequency heating apparatus with a steam generating function, which is a third embodiment of the invention.

FIG. 21 is an explanatory view illustrating a nozzle attached to an end of a duct.

FIG. 22 is an explanatory view illustrating a detachable water storage tank.

5        FIG. 23 is a conceptually and partly sectional view illustrating a body case.

FIG. 24 is a longitudinal side view illustrating a primary part of a high-frequency heating apparatus with a steam generating function, which is a fourth embodiment of the  
10    invention.

FIGS. 25A and 25B are explanatory views illustrating a manner of measuring the temperature of an object by using an infrared ray sensor.

FIG. 26 is a plan view illustrating the outline  
15    configuration of a high-frequency heating apparatus with a steam generating function, which is a fifth embodiment of the invention.

FIG. 27 is a front view illustrating the outline configuration of a high-frequency heating apparatus with a steam  
20    generating function, which is a sixth embodiment of the invention.

FIG. 28 is a plan view illustrating a ventilation duct of the apparatus shown in FIG. 27.

FIG. 29 is a schematic configuration view illustrating the

outline configuration of a high-frequency heating apparatus with a steam generating function, which is a seventh embodiment of the invention.

FIG. 30 is a perspective view illustrating an example of the configuration of the apparatus having a turntable.

FIGS. 31A, 31B, 31C, 31D, and 31E are explanatory views respectively illustrating various kinds of modifications of the steam generating portion.

FIG. 32 is a graph illustrating a manner of change in the weight of a single meat-bun when the meat-bun is heated as an object to be heated.

FIG. 33 is a graph illustrating the difference in amounts of dew condensation formed on a door and in a heating chamber between the cases that a circulating fan is operated, and that the circulating fan is not operated.

FIG. 34 is a histogram illustrating change in each of the amounts of dew condensation formed in the heating apparatus and on the door, which was checked in each of the cases that heating by using a convection heater was performed, and that the heating by using the convection heater was not performed.

FIG. 35 is a graph illustrating results of checking the performance of an infrared ray sensor in each of the cases that the circulating fan was operated during the heating chamber was filled with steam, and that the circulating fan was not operated

during the heating chamber was filled with steam.

Best Mode for Carrying Out the Invention

Hereinafter, preferred embodiments of a high-frequency heating apparatus with a steam generating function according to the invention are described in detail with reference to the accompanying drawings.

First Embodiment

FIG. 1 is a front view illustrating a state of a high-frequency heating apparatus with a steam generating function, which is a first embodiment of the invention and put into a state in which a door thereof is opened. FIG. 2 is a perspective view illustrating an evaporating dish of a steam generating portion for use in this apparatus. FIG. 3 is a perspective view illustrating an evaporating-dish heater and a reflector of the steam generating portion. FIG. 4 is a sectional view illustrating the steam generating portion.

This high-frequency heating apparatus with a steam generating function 100 is a cooking apparatus adapted to heat-treat a to-be-heated object by supplying at least high-frequency waves (microwaves) or steam to a heating chamber 11 that accommodates the object. The high-frequency heating apparatus 100 comprises a magnetron 13 serving as a high-frequency wave generating portion for generating high-frequency waves, a steam generating portion 15 for

generating steam in the heating chamber 11, a circulating fan 17 for agitating and circulating air in the heating chamber 11, a convection heater 19 serving as a chamber air heater for heating air that circulates in the heating chamber 11, and an infrared  
5 ray sensor 20 for detecting the internal temperature of the heating chamber 11 through a detection hole provided in the heating chamber 11.

The heating chamber 11 is formed in a front-open box body case 10. An opening/closing door 21 with a translucent window  
10 21a for opening and closing an object outlet of the heating chamber 11 is provided in a front face portion of the body case 10. The bottom end of the opening/closing door 21 is hinge-connected to a bottom edge of the body case 10, so that the door 21 is enabled to be downwardly opened and upwardly closed. A  
15 predetermined heat insulating space is secured between the wall surfaces of the heating chamber 11 and the body case 10. A heat insulating material is charged into the space, if necessary. Especially, the rear space of the heating chamber 11 is a circulating fan chamber 25 that accommodates the circulating  
20 fan 17 and the drive motor 23 (see FIG. 7). The rear wall of the heating chamber 11 is a partition plate 27 for partitioning the heating chamber 11 from the circulating fan chamber 25. Intake ventilation holes 29 each for intaking air from heating chamber 11 to the circulating fan chamber 25, and blast

ventilation holes 31 each for blasting air to the heating chamber 11 from the circulating fan chamber 25 are provided in the partition plate 27 by differentiating a formation area, in which the intake ventilation holes 29 are formed, from a formation area, in which the blast ventilation holes 31 are formed. The ventilation holes 29 and 31 are formed as punched holes.

The circulating fan 17 is disposed in such a way as to place the center of rotation thereof at the central part of the rectangle partition plate 27. A rectangular-ring-like convection heater 19 is provided in the circulating fan chamber 25 in such a manner as to surround this circulating fan 17. Further, the intake ventilation holes 29 formed in the partition plate 27 are disposed in front of the circulating fan 17. The blast ventilation holes 31 are disposed along the rectangular-ring-like convection heater 19. The apparatus is set so that when the circulating fan 17 is rotated, wind flows from the front side of the circulating fan 17 to the rear side thereof, at which a drive motor 23 is provided. Thus, air in the heating chamber 11 is drawn into the central portion of the circulating fan 17 through the intake ventilation holes 29. Then, the air passes through the convection heater 19 provided in the circulating fan chamber 25. Finally, the air is blasted from the blast ventilation holes 31 into the heating chamber 11. Thus, during agitation, air in the heating chamber 11 is circulated through the circulating

fan chamber 25 by following this flow process.

The magnetron 13 is disposed in the space that is provided under, for example, the heating chamber 11. A stirrer vane 33 is provided at a place at which high-frequency waves generated by the magnetron are received. Further, the high-frequency waves generated from the magnetron 13 are radiated onto the stirrer vane 33 that rotates. Thus, high-frequency waves are supplied into the heating chamber 11 while simultaneously stirred by the stirrer vane 33. Incidentally, the magnetron 13 and the stirrer vane 33 may be provided not only on the bottom part of the heating chamber 11 but on the top surface or a side surface thereof.

The steam generating portion 15 consists of an evaporating dish 35, which has a water storing recess 35a adapted to generate steam by being heated as illustrated in FIG. 2, an evaporating dish heater 37 disposed under the evaporating dish 35 for heating the evaporating dish 35 as illustrated in FIG. 3, and a reflector 39, whose section is nearly U-shaped, for reflecting radiation heat of the heater toward the evaporating dish 35. The evaporating dish 35 is made of, for instance, stainless steel and shaped like an elongated plate. Further, the evaporating dish 35 is disposed on the back-side bottom face, which is on the opposite side of the object outlet of the heating chamber, in such a manner as to extend in a direction along the partition



plate 27. Incidentally, a glass tube heater, and a sheathed heater may be used as the evaporating dish heater 37.

FIG. 5 is a block view illustrating a control system for controlling the high-frequency heating apparatus with a steam  
5 generating function 100. This control system is comprised mainly of a control portion 501 having, for example, a microprocessor. The control portion 501 performs the transfer of signals mainly from and to each of a power supply portion 503, a storage portion 505, an input operation portion 507, a  
10 display panel 509, a heating portion 511, and a cooling fan 61.

The input portion 507 is connected to various switches, such as a start switch 519 for instructing to start heating, a changeover switch 521 for changing over the heating method, such as a high-frequency heating method and a steam heating method,  
15 and an automatic cooking switch 523 for starting execution of a preliminarily prepared program.

The heating portion 511 is connected to a high-frequency wave generating portion 13, a steam generating portion 15, a circulating fan 17, and an infrared ray sensor 20. Further, the  
20 high-frequency wave generating portion 13 operates by collaborating with a wave stirring portion (that is, a drive portion for the stirrer vane) 33. The steam generating portion 15 is connected to the evaporating dish heater 37, and the chamber air heater 19 (that is, the convection heater). Incidentally,

although this block view includes constituent elements (for instance, a water conveyance pump 55, a door blast damper 84, and an exhaust damper 87) other than the aforementioned mechanical constituent elements, such constituent elements  
5 other than the aforementioned mechanical constituent elements are described in the following description of another embodiment.

Next, a basic operation of the aforementioned high-frequency heating apparatus with a steam generating function 100 is described hereinbelow with reference to a  
10 flowchart of FIG. 6.

In an operation procedure, first, food to be heated is put on the dish and then inserted into the heating chamber 11. Subsequently, the opening/closing door 21 is closed. Then, a heating method and a heating temperature or time are set by using  
15 the input operation portion 507 at step 10 (hereunder abbreviated as S10). Subsequently, the start switch is turned on (S11). Then, a heat treatment is performed by an operation of the control portion 501 (S12).

That is, the control portion 501 reads the set heating  
20 temperature or time, and then selects and performs an optimum cooking method according to the read heating temperature or time, and judges (S13) whether or not the apparatus reaches the set heating temperature or time. When reaching a set value of the heating temperature or time, the apparatus stops each of heat

sources and finishes the heating treatment (S14). Incidentally, at S12, generation of steam, an operation of the chamber air heater, rotation of the circulating fan, and a high-frequency heating operation are individually or concurrently performed.

5        An operation in the case of selecting and performing, for instance, a "steam generation & circulating fan ON" mode during the aforementioned operation is described hereinbelow. When this mode is selected, the evaporating dish heater 37 is turned on, as illustrated in FIG. 7 that illustrates an operation of  
10    the high-frequency heating apparatus 100. Thus, water stored in the evaporating dish 35 is heated, so that steam S is generated. The steam S rising from the evaporating dish 35 is drawn into the central part of the circulating fan 17 from the intake ventilation holes 29 provided nearly in the central part of the  
15    partition plate 27. Then, the steam is blasted into the heating chamber 11 from the blast ventilation holes 31 provided in the peripheral part of the partition plate 27 through the circulating fan chamber 25. The blasted steam is agitated in the heating chamber 11. Subsequently, the agitated steam is drawn again  
20    into the circulating fan chamber 25 from the intake ventilation holes 29 provided nearly in the central part of the partition plate 27. Thus, a circulating path is formed in the heating chamber 11 and the circulating fan chamber 25. Incidentally, the apparatus is configured so that the blast ventilation hole

31 is not provided under the place, at which the circulating fan 17 is provided, on the partition plate 27, and that the generated steam is introduced into the intake ventilation holes 29. Further, as indicated by an outline arrow in this figure, the steam is circulated in the heating chamber 11, so that the steam is blown against the object.

At that time, the steam in the heating chamber 11 can be heated by tuning on the chamber air heater 19. Thus, the temperature of steam circulating in the heating chamber 11 can be set at a high value. Therefore, what is called overheated steam is obtained. Consequently, the overheated steam enables cooking to be performed in such a way as to brown the surface of the object M. Further, in the case of performing the high-frequency heating, the magnetron 13 is turned on. Moreover, the stirrer vane 33 is rotated. Thus, even high-frequency cooking can be performed by supplying high-frequency waves into the heating chamber 11 while agitating the high-frequency waves.

Thus, the high-frequency heating apparatus with a steam generating function according to this embodiment is adapted so that steam is not generated outside, but generated inside the heating chamber 11. Consequently, similarly as the case of cleaning the heating chamber 11, the part for generating steam, that is, the evaporating dish 35 can be simply performed. For example, in the process of generating steam, calcium, magnesium,

and chlorine compound contained in water content are sometimes condensed and deposited and fixed onto the bottom portion of the evaporating dish 35. However, the evaporating dish can be cleanly wiped out only by cleaning away substances having adhered to the surface of the evaporating dish 35. Further, when the evaporating dish 35 is awfully stained, the dish 35 may be cleaned by being taken out of the heating chamber 11, as illustrated in FIG. 8. Thus, the cleaning of the evaporating dish 35 can easily be performed. Further, in some case, the evaporating dish 35 can easily be replaced with new one. Therefore, the cleaning of the heating chamber 11 including the evaporating dish 35 is facilitated. Consequently, the internal environment of the heating chamber 11 can be always maintained in a sanitary condition.

Further, this high-frequency heating apparatus is adapted so that the evaporating dish 35 is disposed on the back-side bottom face, which is on the opposite side of the object outlet of the heating chamber 11. Thus, the evaporating dish 35 is not an obstacle to the taking-out of the object. Further, even when the evaporating dish 35 is at a high temperature, there is no fear that a user's hand touches the evaporating dish 35 when the user takes the object into and out of the heating apparatus. Consequently, this heating apparatus excels in safety.

Furthermore, as is understood from the positional relation

between the evaporating dish and the bottom face of the heating chamber, which is illustrated in FIG. 9, the evaporating dish 35 is disposed at a place at which the top face 35b of the evaporating dish 35 is at a height  $h$  above the bottom face of the heating chamber 11. Thus, liquid, such as juice oozed from the object to the bottom face of the heating chamber 11, from flowing into the evaporating dish through the bottom face of the heating chamber 11. Consequently, the evaporating dish 35 can be maintained in a sanitary condition. Further, a surface 22 of a stepped portion between the evaporating dish 35 and the bottom face is directed to the object outlet. Thus, this surface 22 can be easily cleaned.

Furthermore, in this high-speed heating apparatus, steam is generated by heating the evaporating dish 35 by means of the evaporating dish heater 37. Thus, this high-speed heating apparatus can efficiently supply steam by employing a simple structure. Moreover, steam at a somewhat high temperature is generated by being heated. This enables cooking to be performed simply by humidification, and cooking to be performed by heating an object while the object is prevented by simultaneously performing high-frequency heating from being dried.

Furthermore, the radiation heat of the evaporating dish heater 37 is reflected by the reflector 39 toward the evaporating dish 35. Thus, heat generated by the evaporating dish heater

37 can be efficiently utilized for generating steam without waste.

Further, this high-frequency heating apparatus is adapted so that air in the heating chamber 11 is circulated and agitated by the circulating fan. Thus, when the steam heating is performed, steam can be uniformly circulated all around the heating chamber 11. Therefore, the heating chamber 11 is filled with steam. However, the steam is not retained. Thus, steam can be circulated all over the entire heating chamber 11. Consequently, when the temperature of the object is measured by the infrared ray sensor 20, this infrared ray sensor 20 reliably measures the temperature of the object without measuring the temperature of steam particles in the heating chamber 11. Thus, the accuracy of measurement of the temperature of the object can be improved. Consequently, heating treatment to be conducted by referring to a detected temperature can be properly performed without introducing errors.

Further, both the high frequency heating and the steam heating can be concurrently performed as the heating method. Alternatively, one of the high frequency heating and the steam heating can be individually performed. Alternatively, both the high frequency heating and the steam heating can be performed in a predetermined order. These ways of performing the heating method can be freely chosen and performed. Thus, an appropriate

cooking method can be arbitrarily selected according to the kind of food, and to which of a frozen food and a chilled food the object is. Especially, in the case of employing both the high frequency heating and the steam heating, the rate of rise of temperature can be increased. Thus, efficient cooking is enabled.

Further, the apparatus is adapted so that air circulating in the heating chamber 11 can be heated by the chamber air heater 19 equipped in the circulating fan chamber 25. Thus, steam generated in the heating chamber 11 can be freely adjusted. For example, the temperature of steam can be set to be equal to or higher than 100°C. Thus, the temperature of the object can be efficiently raised by overheated steam. Moreover, the surface of the object is dried. In some cases, the surface of the object can be browned. Furthermore, in the case that the object is a frozen food, heat transfer can be efficiently performed owing to large heat capacity of steam. Thus, the object can be quickly defrosted.

Furthermore, in this high-frequency heating apparatus with a steam generating function 100, the circulating fan 17 is accommodated in the circulating fan chamber 25 independently provided outside the heating chamber 11 through the partition plate 27. This eliminates the possibility that juice scattering during the cooking of the object adheres to the circulating fan



17. Simultaneously, ventilation is performed through the ventilation holes 29 and 31 provided in the partition plate 27. Thus, a steam flow caused in the heating chamber 11 can be freely changed according to the positions, at which the ventilation  
5 holes 29 and 31 are provided, and to the opening area of the ventilation holes 29 and 31.

Incidentally, the aforementioned evaporating dish 35 is configured so that the water storing recess may have one of the following shapes. FIG. 10 shows a schematic configuration view  
10 illustrating a section of another shape of the evaporating dish, and also illustrating the evaporating-dish heater. FIG. 11 shows a sectional view taken along line A-A of FIG. 10. FIG. 12 shows another example of a sectional view taken along line A-A of FIG. 10. FIG. 13 shows a schematic configuration view  
15 illustrating a section of still another shape of the evaporating dish.

The evaporating dish 42 shown in FIG. 10 has tapered portions 42a respectively provided at both end portions thereof so that the water storing recess gradually becomes shallower along a  
20 longitudinal direction thereof in each of the tapered portions. Water injected into the water storing recess flows along the tapered portions 42a and is stored in the central part of the evaporating dish at all times. With this configuration, the overall length of the evaporating dish heater 37 can be reduced.

Thus, a compact evaporating dish heater can be obtained. Further, although a transverse section of the bottom face of the water storing recess may be planar as illustrated in FIG. 11, the transverse section thereof may be shaped like a curved surface, as illustrated in FIG. 12. When the transverse section thereof has a curved surface shape, water stored in the water storing recess is always collected at the lowest position that is close to the evaporating dish heater 37. Thus, the heating efficiency of the apparatus is improved. The evaporating dish 43 shown in FIG. 13 is configured so that the bottom face of the water storing recess is formed along the longitudinal direction in such a manner as to have a curved surface shape. Consequently, water is stored at a place in the proximity of the central part at which heat is concentrated. Hence, heating can be performed by enhancing the heat efficiency.

Further, the place, at which the evaporating dish 35 is disposed, in the heating chamber 11 is not limited to the back-side bottom face, which is on the opposite side of the object outlet of the heating chamber 11, and can be suitably changed. Like an example of placement of the evaporating dish shown in FIGS. 14A and 14B, such a place may be the bottom face (in the case of the example illustrated in FIG. 14A, the bottom face at the side of the side wall face 81a illustrated in this figure) along one of the side wall surfaces 81a and 81b. Further, one or more

small evaporating dishes 44 shown in FIG. 14B may be disposed at a nook part (or a corner part) of the bottom face of the heating chamber 11. Each of the small evaporating dishes 44 in this case is, for example, a bowl-like evaporating dish having an evaporating dish heater provided on a lower part thereof. Any  
5 evaporating dish may be disposed at a given place, as long as steam the evaporating dish can supply steam to the heating chamber. Incidentally, usually, the generated steam flow is an upflow. Thus, it is preferable from the viewpoint of agitation of steam  
10 that the evaporating dish is provided under the heating chamber. Preferably, for example, the evaporating dish is provided on a lower half part of the heating chamber or along the bottom face of the heating chamber. Further, when the cleaning of the evaporating dish is easy to perform, the evaporating dish may  
15 be provided in a further lower space under the bottom face of the heating chamber. Furthermore, it is possible that the evaporating dish is not fixed to a predetermined place, and that a user can place the evaporating dish at an arbitrary position. In this case, a steam generating source may be positioned at  
20 an optimal place according to heating conditions.

#### Second Embodiment

Next, a high-frequency heating apparatus with a steam generating function, which is a second embodiment of the invention, is described hereinbelow by referring to FIGS. 15A,

15B, and 16. Incidentally, in the following description, members, which are the same as those of the first embodiment, are designated by the same reference characters used in the description of the first embodiment. Thus, the description of  
5 such members is omitted herein. In the high-frequency heating apparatus with a steam generating function according to the second embodiment, as illustrated in FIG. 15A, the top face of the evaporating dish 35 is covered with a cover 41 provided with an aperture 41a formed in a part thereof. Thus, as illustrated  
10 in FIG. 15B, the place, from which steam is outputted, can be limited to a certain part of the aperture 41a. Further, an amount of supplied steam can be adjusted according to the opening area of the aperture 41a.

As shown in FIG. 16, this aperture 41a is disposed under  
15 the intake ventilation holes 29 provided in the central part of the partition plate 27. Therefore, when the generated steam rises from the aperture 41a, the steam is immediately drawn into the intake ventilation holes 29. Thus, the steam becomes a circulating flow, which is circulated in the heating chamber  
20 11, without waste steam. Further, when the cover 41 is detachably constructed, replacement of the cover 41 with another cover having an aperture of a different size is facilitated. Thus, a proper cover may be used according to the heating conditions.

Further, as illustrated in FIG. 16, in this high-frequency

heating apparatus with a steam generating function, many blast ventilation holes 31a provided in the partition plate 27 are formed in a lower part thereof so that most of steam drawn into the intake ventilation holes 29 can be blasted mainly from a place in the vicinity of the bottom face of the heating chamber 11. This is because of the fact that the steam itself rises, and that thus, when most of the steam is blown out from the lower part, the entire flow can be uniformized; as compared with the case that when most of the steam is blown out from the other part. Thus, a steam flow in the heating chamber 11 goes upwardly after first running low in the vicinity of the bottom face thereof. Incidentally, the blast ventilation holes 31b are provided at a nearly half height part of the partition plate 27. This is because a second-stage tray (not shown), on which a to-be-heated object is mounted, is loaded at a nearly half height position of the heating chamber 11, and that it is necessary to send air to the object mounted on this tray.

With this configuration, a circulating flow, by which heating becomes more effective than the heating performed in the aforementioned first embodiment, is generated. Thus, in the distribution of temperature in the heating chamber 11, variation in the temperature is limited in a small range. Therefore, the object put in the heating chamber 11 can be uniformly heated at high speed.

Further, the cover 41 can be replaced with another cover, whose perspective view is shown in FIG. 17. This cover 45 is formed like a plate, in which plural circular apertures 45a are provided along the longitudinal direction thereof. Leg portions 45b each for forming a gap having a predetermined spacing therefrom to the top face of the evaporating dish 35 are respectively formed at four corners of the back surface of this cover 45 in such a manner as to project therefrom in the direction of thickness thereof. This cover 45 is made of cordierite ( $2\text{MgO} \cdot 2\text{Al}_2\text{O}_3 \cdot 5\text{SiO}_2$ ), which is a low dielectric constant material that is low in a wave loss. This cover 45 is resistant to thermal shock, and has a mechanical strength sufficient to the extent that the cover 45 is hard to break.

As illustrated in FIG. 18, a gap 46 having a predetermined spacing  $t$  is provided by each of the leg portions 45b of the cover 45 to the evaporating dish 35 therefrom. This gap 46 suppresses increase in pressure at the lower part of the cover 45 when water in the evaporating dish 35 is heated. Thus, even when the temperature of water in the evaporating dish 35 rises and a bumping occurs, the pressure is efficiently let out from the gap. This prevents water from scattering from the aperture 45a. Therefore, the generated steam stably and upwardly flows from the aperture 45a. Incidentally, even when a bumping occurs,

a flow path is bent by flange portions 47 provided on both sides of the evaporating dish 35. Thus, water does not scatter from the gap 46. Consequently, water is hardly scattered and stuck to the inside of the heating chamber 11.

5       Incidentally, in the foregoing description, it has been described that a propeller type circulating fan is provided in the apparatus. However, as illustrated in FIG. 19, a sirocco fan 18 may be used as the circulating fan. With this configuration, most of the generated wind can be strongly blown  
10 out of the lower blast ventilation holes 31a. Therefore, during the heating chamber 11 is filled directly with the steam S generated in the steam generating portion 15, the steam S can be circulated therein.

#### Third Embodiment

15       Next, a high-frequency heating apparatus with a steam generating function, which is a third embodiment of the invention, is described hereinbelow by referring to FIGS. 20 to 23. FIG. 20 is a side view illustrating a primary part of the high-frequency heating apparatus with a steam generating function, which is  
20 this embodiment of the invention. FIG. 21 is an explanatory view illustrating a nozzle attached to an end of a duct. FIG. 22 is an explanatory view illustrating a detachable water storage tank. FIG. 23 is a conceptually and partly sectional view illustrating a body case.

As shown in FIG. 20, the high-frequency heating apparatus with a steam generating function according to this embodiment features that a water supply portion 51 for supplying water to the evaporating dish 35 of the steam generating portion 15 is newly added to the apparatus. The water supply portion 51 has a water storage tank 53, and a water conveyance pump 55 for supplying a predetermined mount of water to the evaporating dish 35 from a water supply tank 53, and a water supply conduit 57 for connecting the water storage tank 53 to the evaporating dish 35.

Further, an end portion 57a of the water supply conduit 57, which is provided at the side of the evaporating dish 35, protrudes from the side wall surface 81a of the heat chamber 11, as illustrated in FIG. 21. A nozzle 52 made of a flexible heat resistance resin material is attached to this projected end portion 57a. Therefore, water in the water storage tank 53 is supplied by the water conveyance pump 55 to the evaporating dish 35 through the water supply conduit 57, and the nozzle 52. Incidentally, the end portion 57a of the water supply conduit 57 may be projected from any of the sidewall surface (for instance, 81a) and the wall surfaces of the partition plate 27 at the back side of the heating chamber 11.

With this configuration of this embodiment, water can be continuously supplied to the evaporating dish 35. This enables



long-term steam heating. Further, the nozzle 52 is detachably provided in the apparatus. Thus, similarly as the evaporating dish, even when calcium and magnesium contained in water content are sometimes condensed in the process of generating steam and deposited and fixed thereto, or when juice scattered from the object adheres thereto to thereby stain the nozzle 52, the cleaning of the nozzle 52 can be easily completed only by being removed from the end portion 57a. Alternatively, the nozzle 52 can be replaced with a new nozzle. This facilitates the maintenance thereof. Thus, the cleaning is facilitated and water can be always supplied to the evaporating dish in a sanitary environment by providing the nozzle 52 at the end portion 57a of the water supply conduit 57. Further, the nozzle 52 is made of a soft material. Thus, even when the nozzle 52 touches a food vessel in the heating chamber 11, the nozzle 52 is not damaged. Moreover, the cleaning of the inside of the nozzle 52 is facilitated. Furthermore, when the nozzle 52 is manufactured as an injection mold product formed integrally with the heating chamber 11, the nozzles can be inexpensively supplied by mass production.

Incidentally, the water storage tank 53 is formed as a tank of the cartridge type so as to enhance the tractability thereof, as illustrated in a partly perspective view of a side-face side of the apparatus of FIG. 22. The water storage tank 53 is embedded

in a side wall part, whose temperature is relatively difficult to become high, of the body case 10 in a compact manner so as to prevent the apparatus itself from becoming large when the tank 53 is incorporated into the apparatus. Additionally, the  
5 tank 53 may be disposed on the top or bottom face side of the apparatus by undergoing heat insulation.

Preferably, the water storage tank 53 of the cartridge type can be externally taken out of the apparatus and easily replaced with a new one. Thus, the tractability thereof can be enhanced.  
10 Moreover, the cleaning of the tank is facilitated. For instance, the tank 53 may be enabled to be taken in and out of the apparatus by opening and closing the cover 59 from the side of the apparatus, as illustrated in the figure. Alternatively, the tank 53 may be enabled to be taken in and out of the apparatus from the front  
15 face thereof. Furthermore, preferably, the apparatus is configured so that the water storage tank 53 of the cartridge type is formed from a transparent material, such as a resin or glass, that a body-case-side wall of a tank accommodating portion is made of a transparent material, and that the remaining amount  
20 of water stored in the water storage tank 53 can be externally and visually checked. Further, an occurrence of an empty evaporating dish 35 can be prevented by attaching a remaining-amount sensor to the apparatus and indicating the remaining amount of water, which is stored in the water storage

tank 53, on the display panel 509 or sounding a buzzer by using a loud speaker (not shown).

Incidentally, in the case that the resin water storage tank 53 is disposed in the side wall portion of the apparatus, the water storage tank 53 may be affected by heat outputted from the heating chamber 11. In this case, as illustrated in a conceptual partly sectional view of the body case 10 shown in FIG. 23, the water storage tank 53 is disposed in the middle of a ventilation flue 63 for sending cooling wind into the heating chamber 11 from the cooling fan 61 (for example, a fan, disposed on the bottom portion of the apparatus, for cooling the high frequency wave generating portion 13 during performing high-frequency heating is utilized as the cooling fan). In such a case, the influence of heat, which the water storage tank 53 undergoes, can be minimized. The range of choice of a material of the tank can be widen. This reduces the need for protecting the water storage tank 53 by using the insulating material.

#### Fourth Embodiment

Next, a high-frequency heating apparatus with a steam generating function, which is a fourth embodiment of the invention, is described hereinbelow by referring to FIG. 24.

As is seen from a conceptual longitudinally sectional view of the back-side portion of the body case 10 illustrated in FIG. 24, in addition to the heating chamber 11 and the circulating

fan chamber 25, a self-cooled fan chamber 71 partitioned from both the chambers 11 and 25 is provided therein. This self-cooled fan chamber 71 accommodates an infrared ray sensor 20 for detecting the temperature in the heating chamber 11 through a  
5 detection hole 73 provided in the wall surface of the heating chamber 11, and a self-cooled fan 75, concentrically provided with a drive shaft of the circulating fan 17, for cooling a drive motor 23. Further, the pressure  $P_1$  in the self-cooled fan chamber 71 in the vicinity of the detection hole 73 is maintained by  
10 wind pressure due to rotation of the self-cooled fan 75 at a value that is higher than the pressure  $P_2$  in the heating chamber 11.

Generally, in the case that a protective transparent member, such as glass, is attached to the detection hole 73 when the  
15 temperature in the heating chamber 11 is measured by the infrared ray sensor 20, steam sticks to the glass, so that accurate measurement thereof cannot be achieved. Thus, the detection hole 73 is formed as a simple through hole, without attaching an interposition thereto. However, in the case of a through  
20 hole, air coming from the heating chamber 11 freely enters the through hole. Thus, steam may stick to the infrared ray sensor 20. Consequently, the accuracy of measurement of the temperature of the object is degraded.

To deal with this problem, the high-frequency heating

apparatus with a steam generating function is adapted so that the pressure  $P_1$  in the self-cooled fan chamber 71 in the vicinity of the detection hole 73 is maintained by wind pressure due to rotation of the self-cooled fan 75 at a value that is higher than the pressure  $P_2$  in the heating chamber 11. Thus, air in the heating chamber 11 can be prevented from entering the self-cooled fan chamber 71 that accommodates the infrared ray sensor 20. Therefore, detection accuracy can be prevented from being degraded owing to adhesion of stain to the infrared ray sensor 20. This enables heat-treatment under accurate temperature management. Consequently, the adjustment of the degree of heating can be achieved as desired.

Hereunder, a temperature measuring method using the infrared ray sensor 20 is described. FIGS. 25A and 25B are explanatory views illustrating a manner of measuring the temperature of the object by using the infrared ray sensor. The infrared ray sensor 20 performs scanning in the direction of an arrow in FIG. 25A by swinging itself while the temperatures at a plurality of points ( $n$  points) are simultaneously detected at a time. Thus, the infrared ray sensor 20 detects the temperatures at a plurality of measurement points ( $m$  points arranged in a scanning direction) in the heating chamber 11. Therefore, the temperatures at  $n \times m$  measurement points shown in FIG. 25B can be detected by performing the scanning once. The

temperature of the object M is determined by finding a position, at which the object M is put on, according to a rate of increasing the temperature, which is continuously detected at each of the measurement points, to an elapsed time, and treating the  
5 temperature, which is detected at the found position, as the temperature of the object M.

A range, in which the infrared ray sensor 20 measures the temperature, is the bottom face of the heating chamber 11 except the place at which the evaporating dish 35 is disposed. Therefore,  
10 the evaporating dish 35 is disposed at a place that is substantially outside a range in which temperature measuring waves are irradiated from the infrared ray sensor 20.

Incidentally, the apparatus may employ a method according to which the temperature measurement is conducted by causing the  
15 infrared ray sensor 20 to perform scanning on the entire bottom surface of the heating chamber 11, and then invalidating data detected at the position of the evaporating dish 35.

#### Fifth Embodiment

Next, a high-frequency heating apparatus with a steam  
20 generating function, which is a fifth embodiment of the invention, is described hereinbelow by referring to FIG. 26.

As is seen from a conceptual transverse sectional view of the body case 10 shown in FIG. 26, the high-frequency heating apparatus with a steam generating function according to this

embodiment is constructed so that an outside-air supply opening 82, from which outside-air is blown against the inner surface of the translucent window 21a of the opening/closing door 21, is provided in a side wall surface 81a in the vicinity of the opening/closing door 21 of the heating chamber 11. The outside-air supply opening 82 is formed in such a way as to communicate with a side portion ventilation flue 83 secured between the body case 10 and the side wall surface of the heating chamber 11. A rear portion ventilation flue 85 is connected to the side portion ventilation flue 83 through a damper 84. Furthermore, the apparatus is adapted so that wind sent from the cooling fan 61 provided in the bottom portion of the apparatus is blown into the heating chamber 11 from the outside-air supply opening 82 through the side portion ventilation flue 83 by switching the damper 84. Incidentally, when the damper 84 is switched to the other damping condition, cooling wind is exhausted from an exhaust outlet 88 to the outside.

Thus, outside-air is blown against the inner surface of the translucent window 21a, so that the translucent window 21a is prevented from being steamed up when the steam heating or the high-frequency heating is performed. The condition of the heated object in the heating chamber 11 can be externally and visually checked. Incidentally, it is sufficient that the blowing of outside air is performed only when needed. For example,

in the case that the blowing of outside-air is started a predetermined time before the finish of the heating, the translucent window 21a is defogged at the finish of the heating. Moreover, steam can be restrained from growing dense at the near side when the door is opened. Furthermore, the apparatus is configured so that outside-air is blown against the translucent window 21a by being forcibly introduced. Thus, this embodiment particularly excels in the effect of expelling steam (that is, the cooling effect) before the opening/closing door 21 is opened.

#### Sixth Embodiment

Next, a high-frequency heating apparatus with a steam generating function, which is a sixth embodiment of the invention, is described hereinbelow by referring to FIGS. 27 and 28.

As is seen from a front view of the outline configuration of the body case shown in FIG. 27, and as is seen from a plan view illustrating a ventilation duct shown in FIG. 28, the high-frequency heating apparatus with a steam generating function according to this embodiment is configured so that the outside-air supply opening 82 is disposed at the near side of the upper part of one 81a of the side wall surfaces of the heating chamber 11, and that the exhaust outlet 86, from which air in the heating chamber 11 is exhausted, is disposed at the back-side of the lower part of the other side wall surface 81b of the heating chamber 11. In this case, the exhaust outlet 86 is directly



connected to the outside through the damper 87. Thus, the apparatus is adapted so that air and steam in the heating chamber 11 can be immediately and externally exhausted.

Thus, an air flow in the heating chamber 11 at exhaustion  
5 is directed from the top face side to the bottom face side by positioning the exhaust outlet 86 in the vicinity of the bottom face of the heating chamber 11. Consequently, the air in the heating chamber 11 can be effectively exhausted without causing air to stagnate. Further, the destination of exhausted air is  
10 outside the apparatus, so that the exhausted air becomes outside-air. Thus, this embodiment has an effect of restraining evaporants, which are generated from the object, from adhering onto the inner wall of the apparatus. Further, the outside-air supply opening 82 is provided at the near side, while the exhaust  
15 outlet 86 is provided at the back-side of the heating chamber 11. Thus, a flow of air to be exhausted from the heating chamber 11 runs diagonally across a rectangular parallelepiped space in the heating chamber 11. Consequently, quick ventilation can be more efficiently performed.

## 20 Seventh Embodiment

Next, a high-frequency heating apparatus with a steam generating function, which is a seventh embodiment of the invention, is described hereinbelow by referring to FIG. 29.

As is seen from a schematic configuration view of the

apparatus shown in FIG. 29, water in the evaporating dish 35 is evaporated by the high-frequency heating without providing an evaporating dish heater in the apparatus. In this case, although water in the evaporating dish 35 may be

5 high-frequency-heated by being agitated by the ordinary stirrer vane 33, it is preferable that the stirrer vane 33 is designed in such a way as to enable high-frequency waves outputted by the stirrer vane 33 to be directed to the evaporating dish 35, and as to enable the evaporating dish 35 to be intensively heated.

10 This is realized by stopping the stirrer vane 33, which usually rotates to thereby uniformly heat the entire heating chamber 11, at a specific place. For instance, in the case that a control operation is performed in such a way as to cause the apparatus to resume ordinary heat-treatment of after water in the

15 evaporating dish 35 is intensively heated for a predetermined time, both the generation of steam and the high-frequency heating can be simultaneously performed without providing an evaporating dish heater in the apparatus.

Thus, the evaporating dish heater is omitted. Further,

20 water in the heating chamber 11 is heated and vaporized by utilizing high frequency waves. Consequently, the configuration of the apparatus can be simplified. Moreover, the cost of the apparatus can be reduced.

Incidentally, in the foregoing description of the

aforementioned embodiments, it has been described that the stirrer vane 33 is provided in the apparatus so as to stir high frequency waves. However, the invention can be similarly applied to an apparatus of the configuration, in which an object  
5 to be heated is uniformly heated by using a turntable 91, as illustrated in FIG. 30. That is, the generation of steam can be achieved by such an apparatus, which is by no means inferior to the aforementioned embodiments in the steam generating function, by disposing the turntable 91 at the near side of the  
10 evaporating dish 35, as viewed in this figure, on the inner bottom face of the heating chamber 11 except the place, on which the evaporating dish 35 is disposed, in the illustrated case.

Next, a modification of the steam generating system of the steam generating portion 15 is described with reference to FIGS.  
15 31A to 31E. In this figure, reference numeral 11 designates a heating chamber. Reference numerals 401, 402, and 403 denote a cartridge type water tank, a pump, and a draining mechanism, respectively. FIG. 31A shows a system of the most simple type using the aforementioned dish 35 and the evaporating dish heater  
20 37. In the case of using a glass-tube-type far-infrared ray heater as the evaporating dish heater 37, an amount of generated heat is about 10g/min. Thus, the system comes to be able to generate steam in about 40 seconds. Furthermore, when a halogen heater is used as the evaporating dish heater 37, an amount of

generated heat is at the same level as that in the case of using the glass-tube-type far-infrared ray heater. Further, the system comes to be able to generate steam in about 25 seconds. The system of this type has advantages in that the structure thereof is simple, that the cost thereof is low, and that a time taken until the generation of steam is short.

FIG. 31B shows the system of the type adapted to heat water stored in the evaporating dish 35 by using an inverter power supply 405 and an IH (electromagnetic induction heating) coil 406. In the case of the system of this type, an amount of generated heat is about 5g/min. Further, the system comes to be able to generate steam in about 15 seconds. Thus, the system of this type has an advantage in that a time taken until the generation of steam is short.

FIG. 31C shows the system of the type using what is called a dropping type IH steamer 406. The system of this type is adapted to generate steam by dropping water droplets onto a member heated by using the inverter power supply 405 and the IH (electromagnetic induction heating) coil 406. Although the system of this type is large in size, an amount of generated heat is about 20g/min. Further, the system comes to be able to generate steam in about 5 seconds.

FIG. 31D shows the system of the type adapted to generate steam by using a boiler 407. In the case of the system of this

type, an amount of generated heat is about 12 to 13g/min. Further, the system comes to be able to generate steam in about 40 seconds. Although the structure of the draining mechanism 403 becomes complex, the system can be configured at low cost.

5        FIG. 31E shows the system of the type adapted to generate steam by using an ultrasonic steam generator 40S. In the system of this type, generated steam is sucked out by a fan F. Subsequently, after the generated steam is heated by a chamber air heater 19, the heated steam is supplied to the heating chamber  
10 11.

#### Examples

Hereinafter, examples of various heating processes performed by the aforementioned high-frequency heating apparatus with a steam generating function according to the  
15 invention are described.

FIG. 32 illustrates a manner of change in the weight of a single meat-bun when the meat-bun was heated as an object to be heated. In the case that the meat-bun was heated by steam (that is, steamed), it can be decided according to increase in  
20 amount of water content whether or not the meat-bun was finally brought into a good condition by being heated.

Line A indicates change in the weight of the meat-bun in the case that the meat-bun is steam-heated by heating a convection heater as a chamber air heater at 570 W without operating a

circulating fan. Line B indicates change in the weight of the meat-bun in the case that the meat-bun was steam-heated by heating a convection heater as a chamber air heater at 680 W without operating the circulating fan. It is understood from these  
5 broken line graphs that in both cases, a rate of an increase in the amount of water content to a heating time was relatively low, and that thus, good effects of steaming were not obtained only by simply filling the heating chamber 11 with steam and heating the convection heater.

10       Conversely, in the case indicated by Lines C and D, in which the circulating fan is operated, a relatively high amount of water content was obtained. Moreover, good effects of steaming were obtained. Furthermore, it is found that even in the case indicated by Line C, in which the number of revolutions of the  
15 circulating fan was reduced, good effects of steaming were obtained when time passed. That is, the amount of water content can be increased by an operation of the circulating fan. Therefore, the circulation of steam is indispensable to the steam heating.

20       FIG. 33 illustrates the difference in amounts of dew condensation formed on the door and in the heating chamber between the cases that the circulating fan was operated, and that the circulating fan was not operated. It was found that although the amount of dew condensation increased with the passage of

time, the amount of dew condensation could be largely decreased by operating the circulating fan. When 10 minutes passed since the initiation of the heating, the amounts of dew condensation formed on the door and in the heating chamber were 7.6g and 14.4g, respectively, in the case that the circulating fan was not rotated. However, in the case that the circulating fan was not rotated, such amounts of dew condensation were decreased to 3.1g and 7.3g, respectively. Thus, the amount of dew condensation can be reduced to half.

FIG. 34 shows results of checking change in each of the amounts of dew condensation formed in the heating apparatus and on the door in each of the cases that heating by using the convection heater was performed, and that the heating by using the convection heater was not performed. Especially, the amount of dew condensation formed in the heating chamber was considerably decreased from 7.3g, which was a value of that of dew condensation at the finish of heating, to 3.0g, which was a value of that of dew condensation when 1 minute passed since then, and to 0.3g, which was a value of that of dew condensation when 2 minutes passed since the finish of heating, by operating the convection heater. Further, the amount of dew condensation formed on the door was liable to decrease, for instance, from 3.1g, which was a value of that of dew condensation at the finish of heating, to 2.9g, which was a value of that of dew condensation

when 1 minute passed since then, and to 1.3g, which was a value of that of dew condensation when 2 minutes passed since the finish of heating, by operating the convection heater.

FIG. 35 is a graph illustrating results of checking the performance of the infrared ray sensor in each of the cases that the circulating fan was operated during the heating chamber was filled with steam, and that the circulating fan was not operated during the heating chamber was filled with steam. In the case that the circulating fan was not operated, a fluctuation occurred in values measured by the infrared ray sensor halfway in the measurement, so that the accuracy of the measurement was degraded. Conversely, in the case that the circulating fan was operated, stable measurements could be conducted at all times. That is, the detection level of the infrared ray sensor can be stabilized by operating the circulating fan. Consequently, the measurement of the temperature can be performed in good conditions.

#### Industrial Applicability

According to the high-frequency heating apparatus with a steam generating function, steam is generated in the heating chamber. Thus, steam can be quickly supplied into the heating chamber. Further, the efficiency in generating steam can be enhanced. Moreover, because of the presence of the steam generating portion in the heating chamber, the cleaning of the



steam generating portion can be performed by being simplified, simultaneously with the cleaning of the inside of the heating chamber. The internal environment of the heating chamber can be maintained in a sanitary condition. Furthermore, the heating apparatus is adapted so that air in the heating chamber is circulated and agitated by the circulating fan. Thus, especially when the steam heating is performed, steam can be uniformly circulated all around the heating chamber. Consequently, the heating efficiency in heating the object can be enhanced. Further, both the high frequency heating and the steam heating can be concurrently performed as the heating method. Alternatively, one of the high frequency heating and the steam heating can be individually performed. Alternatively, both the high frequency heating and the steam heating can be performed in a predetermined order. These ways of performing the heating method can be freely chosen and performed. Thus, an appropriate cooking method can be selected according to the kind of food, and to which of a frozen food and a chilled food the object is. Especially, in the case of employing both the high frequency heating and the steam heating, the rate of rise of temperature can be increased. Thus, quick and efficient cooking is enabled.

Further, the high-frequency heating apparatus of the invention with a steam generating function is adapted so that air circulating in the heating chamber is heated by the chamber

air heater. Thus, the temperature of steam can be freely raised. Efficient rise of the temperature of the object is realized owing to the overheated steam by raising the temperature of the steam. Moreover, the rise of the temperature of the steam enables the  
5 high-temperature steam to brown the object. Furthermore, when the object is a frozen food, the defrosting of the object can be more efficiently performed.

## CLAIMS

1. A high-frequency heating apparatus with a steam generating function, which heat-treats an object by supplying at least high-frequency waves or steam to a heating chamber that  
5 accommodates said object, comprising:

a high frequency wave generating portion;

a steam generating portion for generating steam in said heating chamber; and

a circulating fan for agitating air in said heating chamber.

10

2. The high-frequency heating apparatus according to claim 1, which further comprises a chamber air heater for heating air that circulates in said heating chamber.

15 3. The high-frequency heating apparatus according to claim 1, wherein said steam generating portion includes an evaporating dish that is provided in said heating chamber and that has a water storing recess adapted generate steam by being heated.

20

4. A high-frequency heating apparatus with a steam generating function, which heat-treats an object by supplying at least high-frequency waves or steam to a heating chamber that accommodates said object, comprising:

a high frequency wave generating portion; and  
a steam generating portion, provided in said heating chamber,  
for generating steam from an evaporating dish that has a water  
storing recess adapted to generate steam by being heated.

5

5. The high-frequency heating apparatus according to  
claim 3 or 4, wherein said evaporating dish is disposed on a  
back-side bottom face, which is on the opposite side of an object  
outlet of said heating chamber, from which the object is taken

10 out.

6. The high-frequency heating apparatus according to  
claim 3 or 4, wherein said evaporating dish is disposed on a  
bottom face along one of side wall surfaces of said heating

15 chamber.

7. The high-frequency heating apparatus claim 3 or 4,  
wherein said evaporating dish is disposed at a place at which  
a top face of said evaporating dish is at a predetermined height

20 above a bottom face of said heating chamber.

8. The high-frequency heating apparatus according to  
claim 3 or 4, further comprising an infrared ray sensor for  
measuring a temperature in said heating chamber, and wherein

said evaporating dish is disposed at a place that is substantially outside a temperature measurement area in which said sensor measures the temperature.

5           9. The high-frequency heating apparatus according to claim 3 or 4, wherein said evaporating dish is disposed in such a manner as to be detachable from said heating chamber.

10           10. The high-frequency heating apparatus according to claim 3 or 4, wherein said evaporating dish has tapered portions respectively provided at both end portions thereof so that said water storing recess gradually becomes shallower along a longitudinal direction thereof in each of said tapered portions.

15           11. The high-frequency heating apparatus according to claim 3 or 4, wherein said evaporating dish has a cover, which covers the top face of said evaporating dish and which has at least one aperture that opens a part of the top face thereof.

20           12. The high-frequency heating apparatus according to claim 11, wherein said cover is disposed in such a manner as to be able to be detached from said evaporating dish.

13. The high-frequency heating apparatus according to

claim 11, wherein a leg portion for forming a gap having a predetermined height to said evaporating dish therefrom is provided on a bottom surface of said cover.

5        14. The high-frequency heating apparatus according to claim 11, wherein a plurality of said apertures are provided in such a way as to extend along a longitudinal direction of said cover.

10       15. The high-frequency heating apparatus according to claim 11, wherein said cover is made of a low-dielectric-constant material.

15       16. The high-frequency heating apparatus according to claims 3 or 4, wherein said steam generating portion has an evaporating dish heater for heating said evaporating dish.

20       17. The high-frequency heating apparatus according to claim 16, wherein said steam generating portion has a reflector for reflecting radiation heat, which is radiated from said evaporating dish heater, to said evaporating dish.

18. The high-frequency heating apparatus according to claim 3 or 4, which further comprises an electromagnetic wave

stirring portion for stirring high frequency waves sent from said high frequency wave generating portion and for supplying the high frequency waves to said evaporating dish.

5        19. The high-frequency heating apparatus according to claim 1, 3, or 4, which further comprises a water supply portion for supplying water to said steam generating portion.

10       20. The high-frequency heating apparatus according to claim 19, wherein said water supply portion comprises a water storage tank and a water conveyance pump for supplying a predetermined amount of water to said evaporating dish through a water supply conduit.

15       21. The high-frequency heating apparatus according to claim 20, wherein said water supply portion has a nozzle, detachably provided at a water supply conduit end portion disposed on a wall surface of said heating chamber, for supplying water to said evaporating dish.

20       22. The high-frequency heating apparatus according to claim 21, wherein said nozzle is formed from a heat resistance resin material.

23. The high-frequency heating apparatus according to claim 1, wherein said heating chamber is partitioned from circulating fan chamber, in which said circulating fan is disposed, through a partition plate, and wherein at least one  
5 ventilation hole for enabling said heating chamber and said circulating fan chamber to communicate with each other is formed in said partition plate.

24. The high-frequency heating apparatus according to  
10 claim3, said evaporating dish has a cover, which covers the top face of said evaporating dish and which has at least one aperture that opens a part of the top face thereof, and

wherein said heating chamber is partitioned from circulating fan chamber, in which said circulating fan is  
15 disposed, through a partition plate, wherein a ventilation hole for enabling said heating chamber and said circulating fan chamber to communicate with each other is formed in said partition plate, and wherein said aperture is disposed under one ventilation hole for intaking air from said heating chamber to  
20 said circulating fan chamber, among said ventilation holes formed in said partition plate.

25. The high-frequency heating apparatus according to claim 23 or 24, wherein a ventilation hole for blasting air from



said circulating fan to said heating chamber is provided at least in a lower half portion of said partition plate, and wherein air in said heating chamber is circulated upwardly by said circulating fan.

5

26. The high-frequency heating apparatus according to claim 23 or 24, wherein a self-cooled fan chamber partitioned from said heating chamber and said circulating fan chamber is provided in addition thereto, wherein an infrared ray sensor  
10 for detecting a temperature in said heating chamber through a detection hole provided in the wall surface of said heating chamber, and a self-cooled fan concentrically, provided with a drive shaft of said circulating fan, for cooling a drive motor are accommodated in said self-cooled fan chamber, and wherein  
15 a pressure in a self-cooled fan chamber in the vicinity of the detection hole is maintained by rotation of said self-cooled fan at a value that is higher than a value of a pressure in said heating chamber.

20

27. The high-frequency heating apparatus with a steam generating function according to claim 1, 3, or 4, wherein a supply opening for blowing outside-air to an inner surface of a translucent window of an opening/closing door is provided in a side wall in the vicinity of said opening/closing door of said

heating chamber.

28. The high-frequency heating apparatus with a steam  
generating function according to claim 27, wherein said supply  
5 opening is provided in an upper part of one of side wall faces  
of said heating chamber, and wherein an exhaust outlet for  
exhausting air of said heating chamber is provided in a lower  
part of the other side wall surface of said heating chamber.

FIG. 1

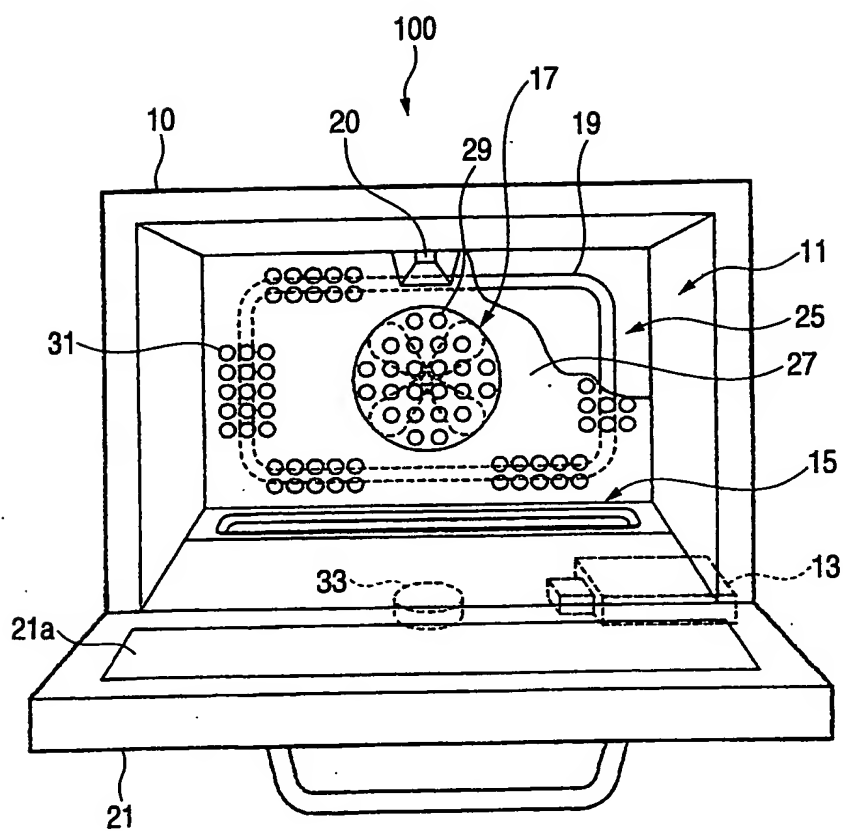


FIG. 2

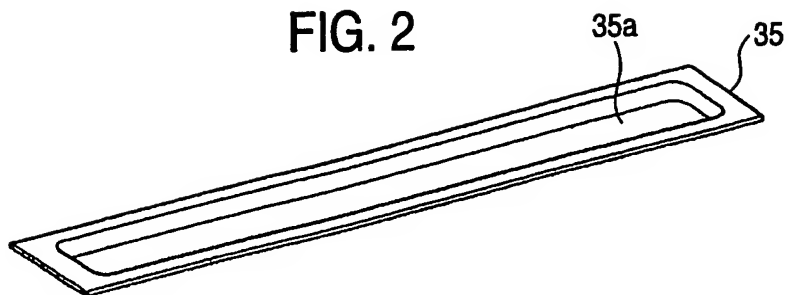


FIG. 3

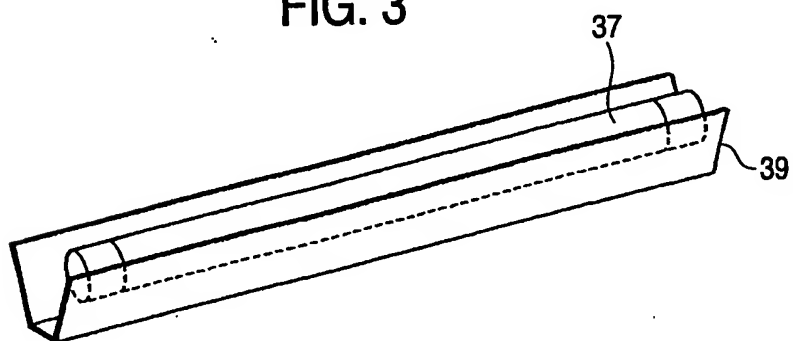


FIG. 4

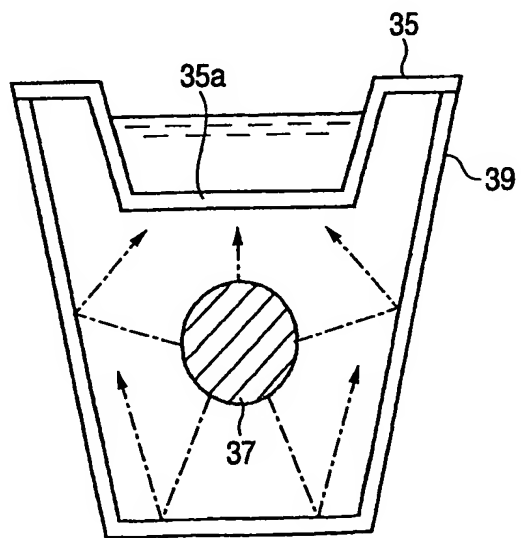


FIG. 5

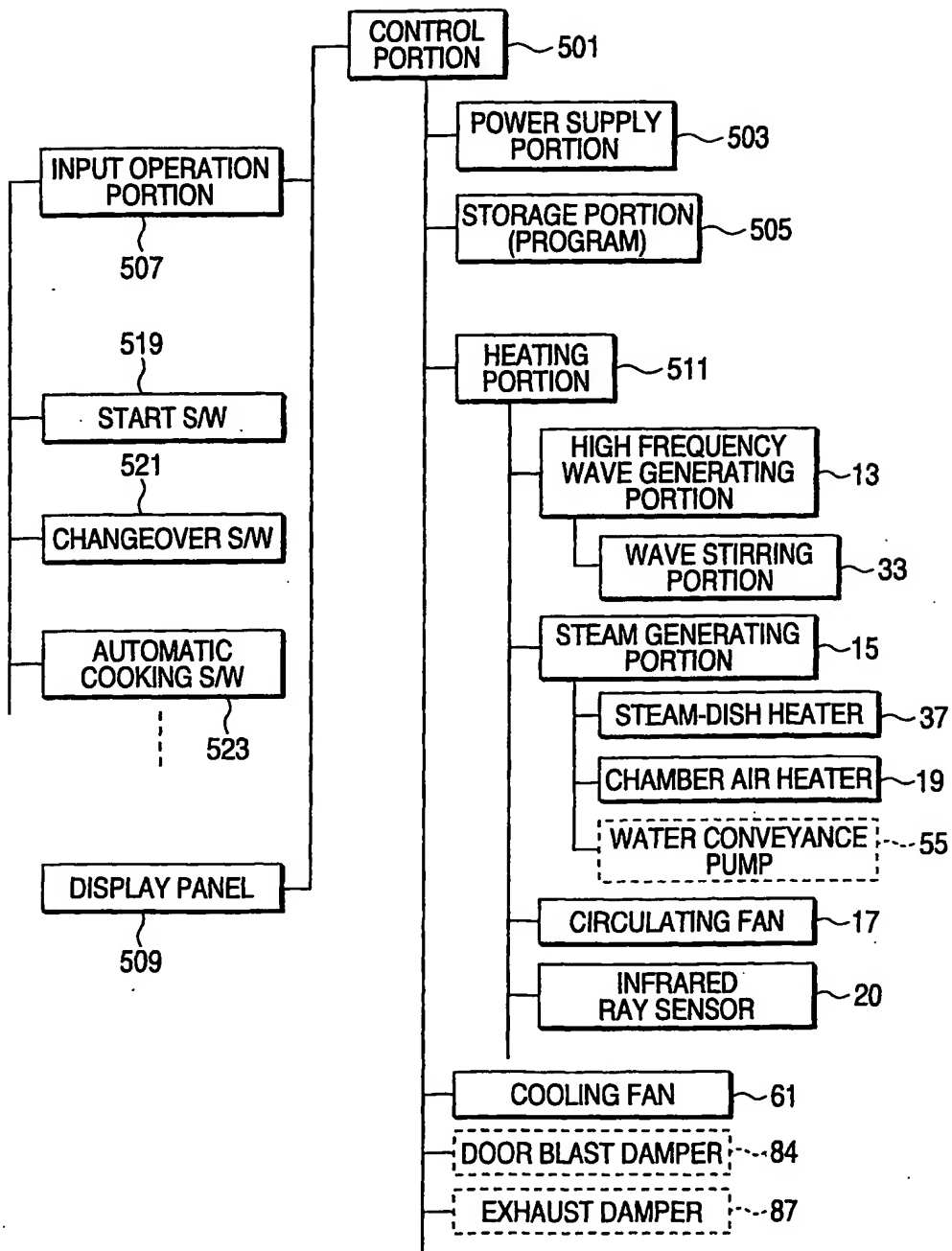


FIG. 6

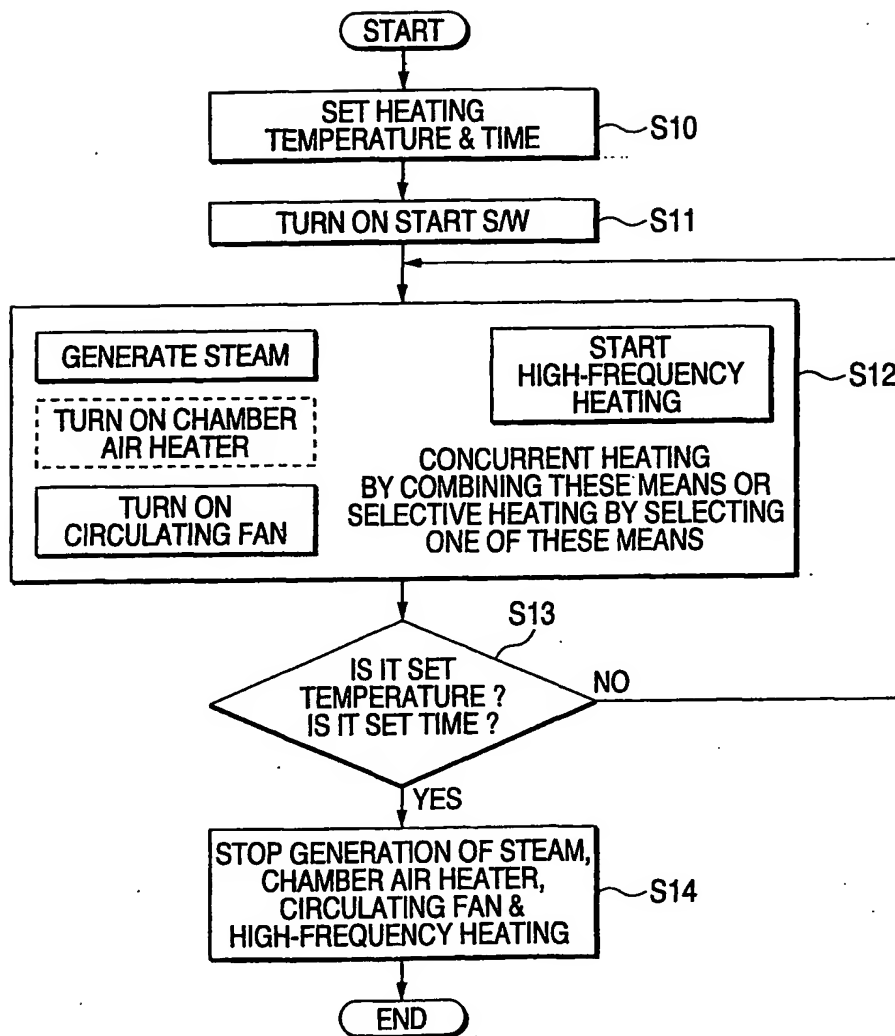




FIG. 8

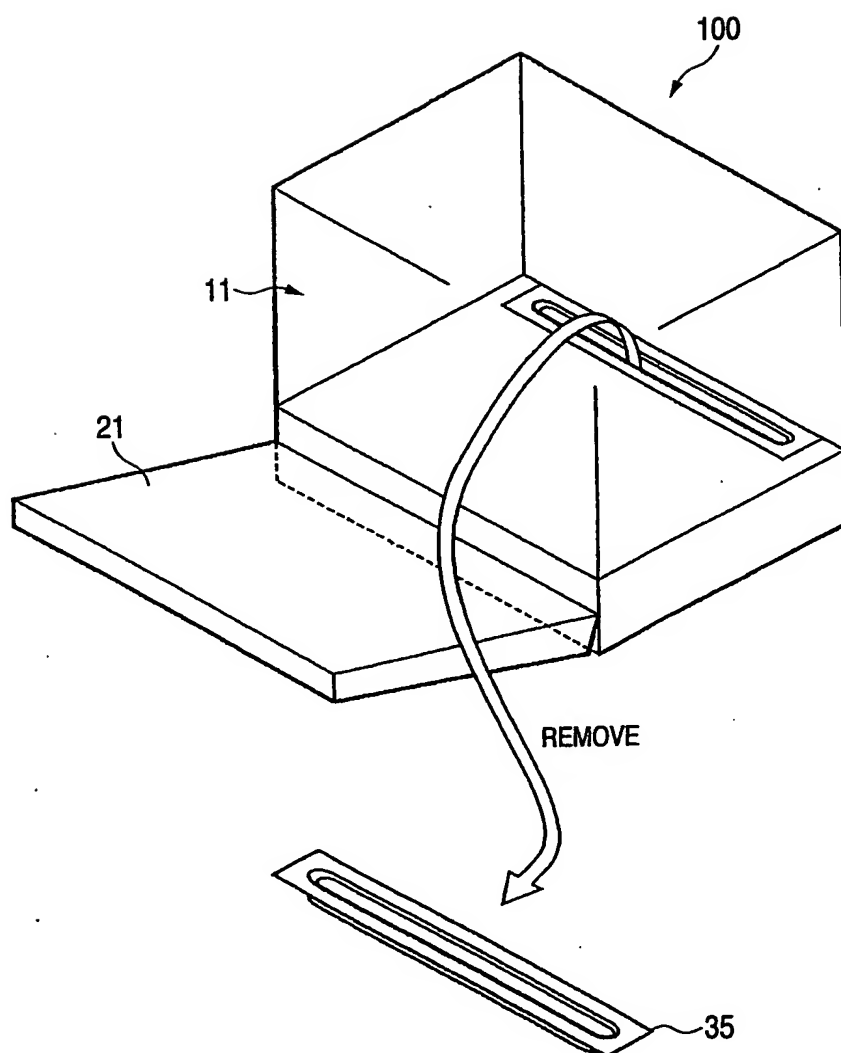




FIG. 9

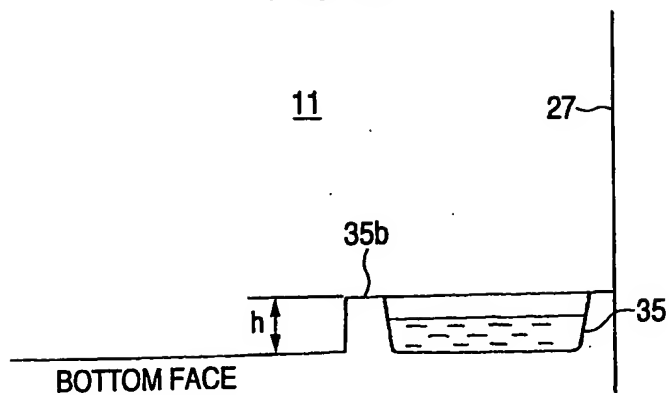


FIG. 10

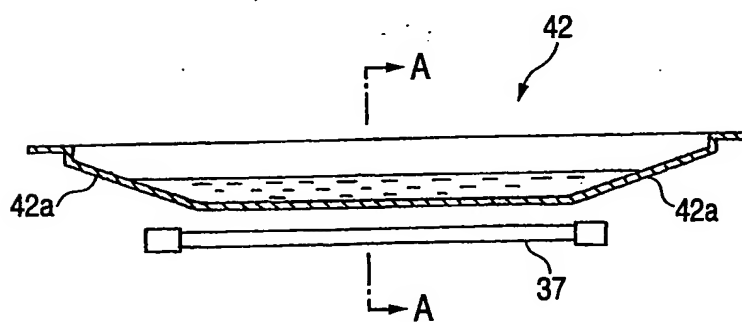


FIG. 11

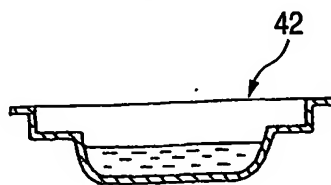


FIG. 12

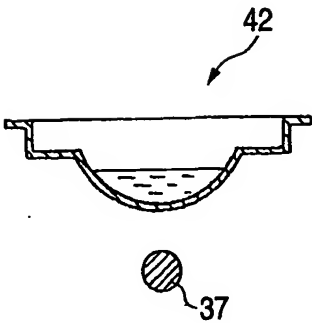


FIG. 13

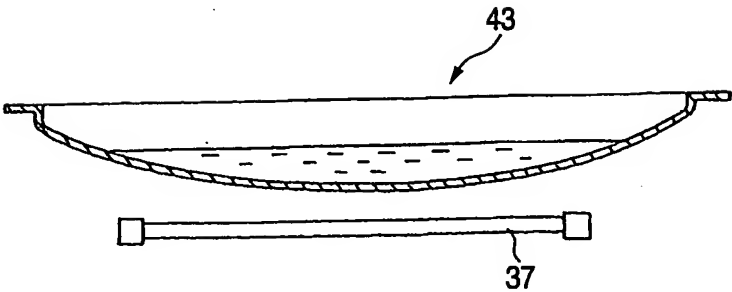


FIG. 14A

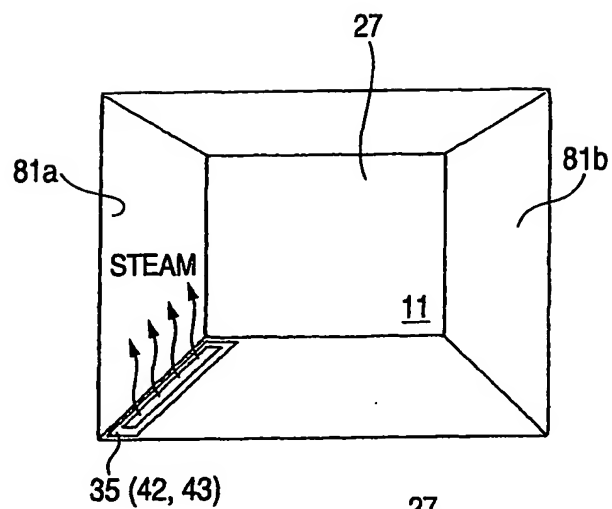


FIG. 14B

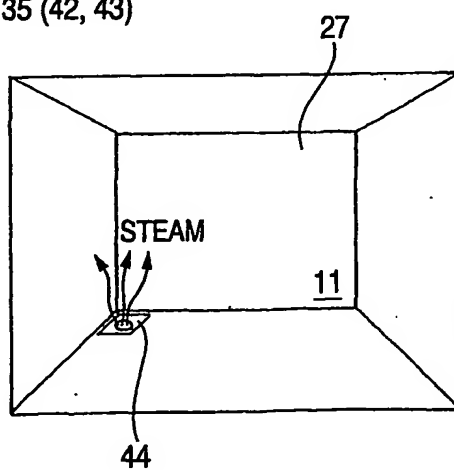


FIG. 15A

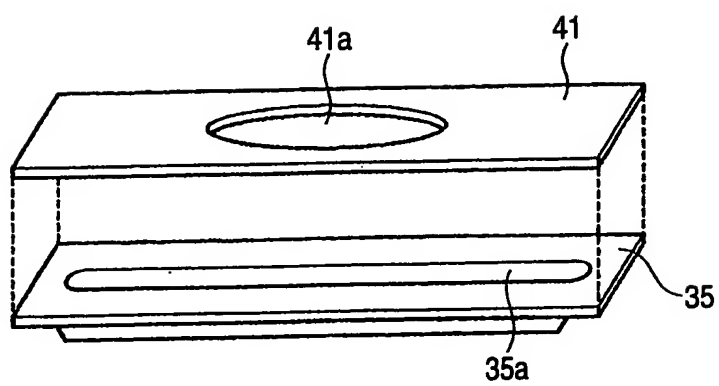


FIG. 15B

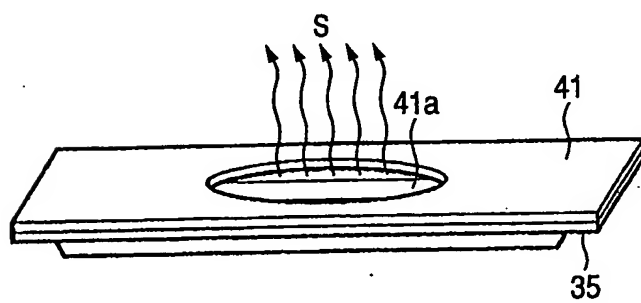


FIG. 16

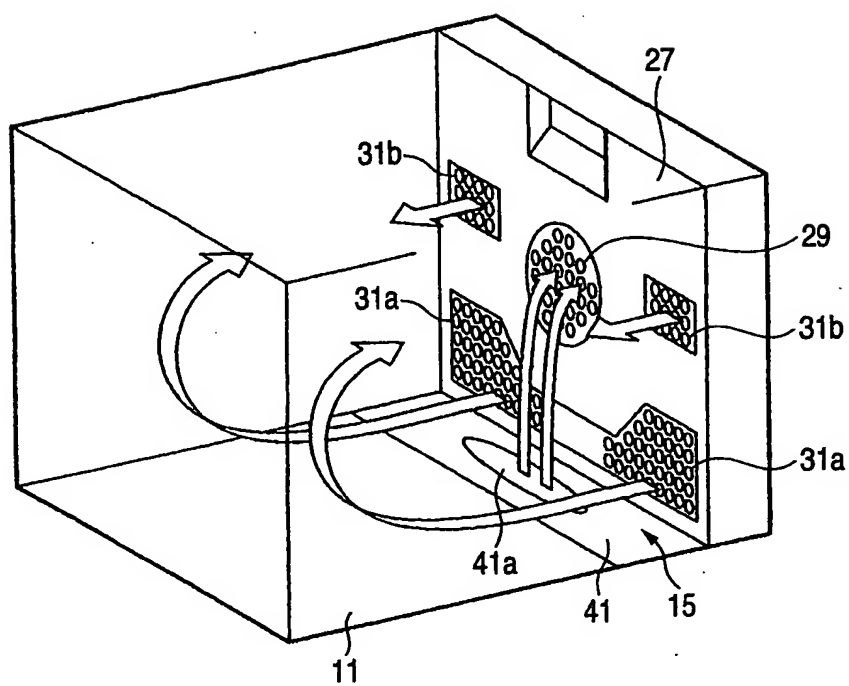


FIG. 17

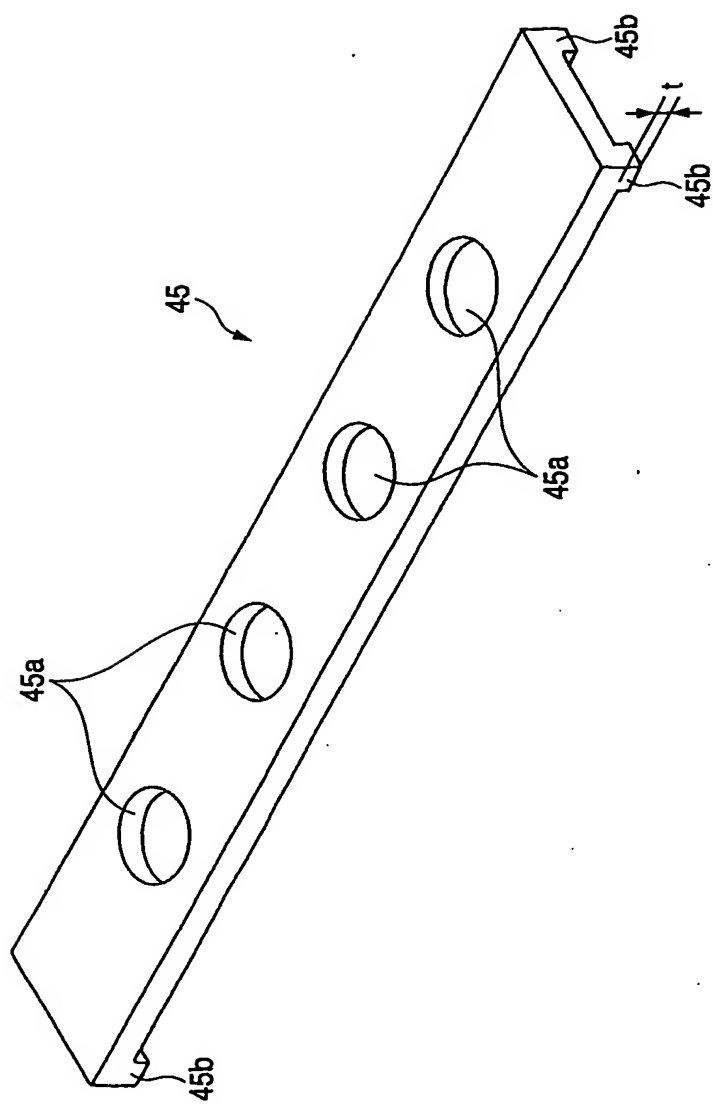


FIG. 18

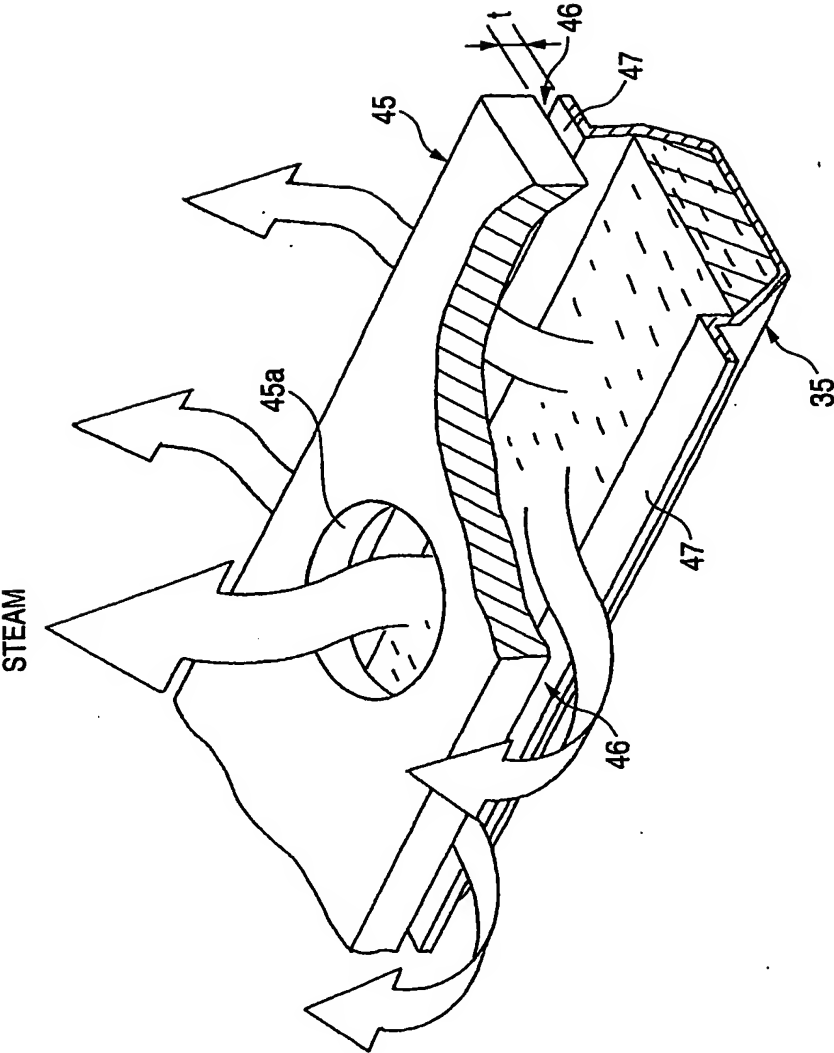


FIG. 19

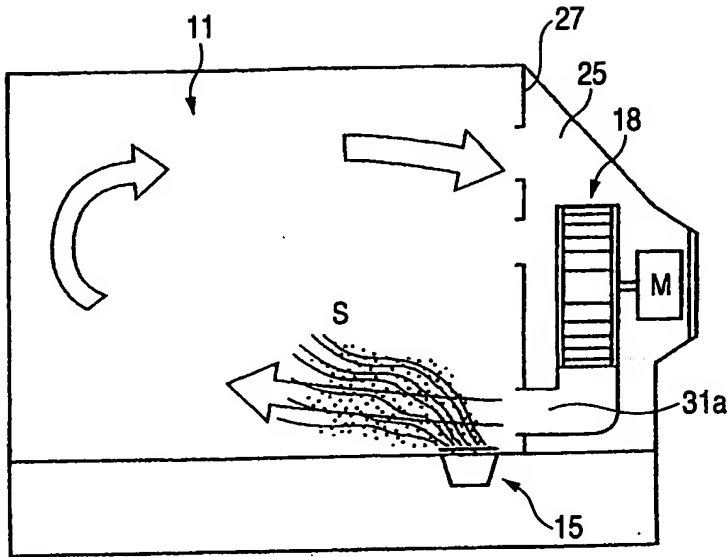


FIG. 20

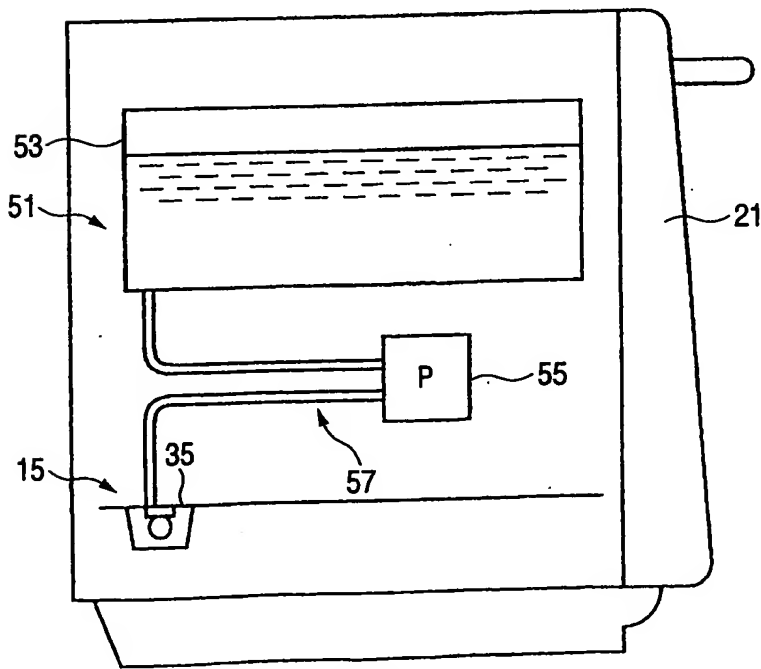




FIG. 21

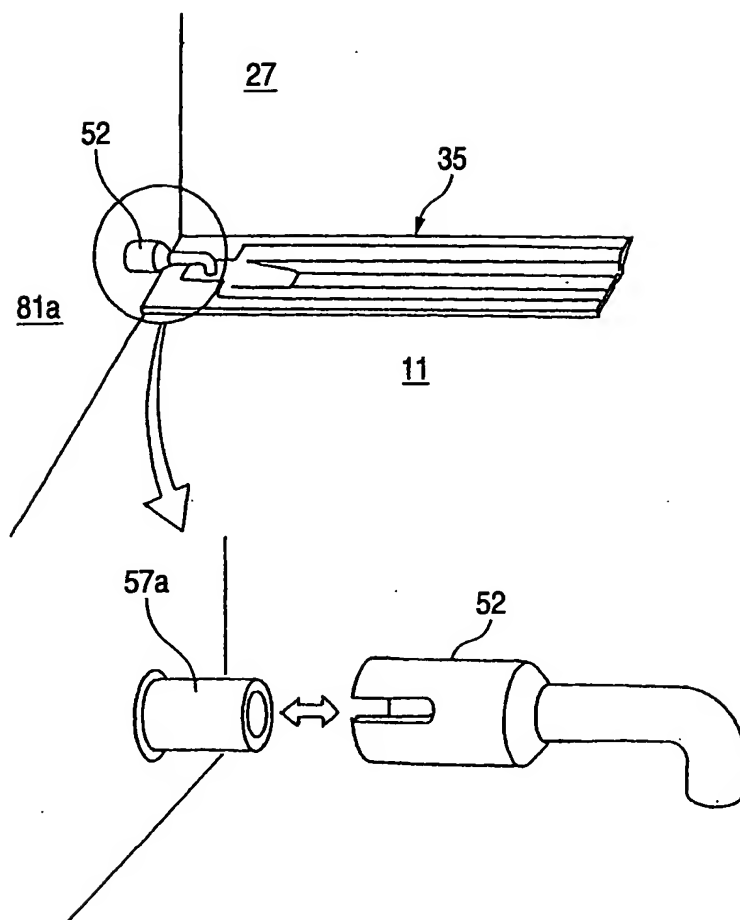


FIG. 22

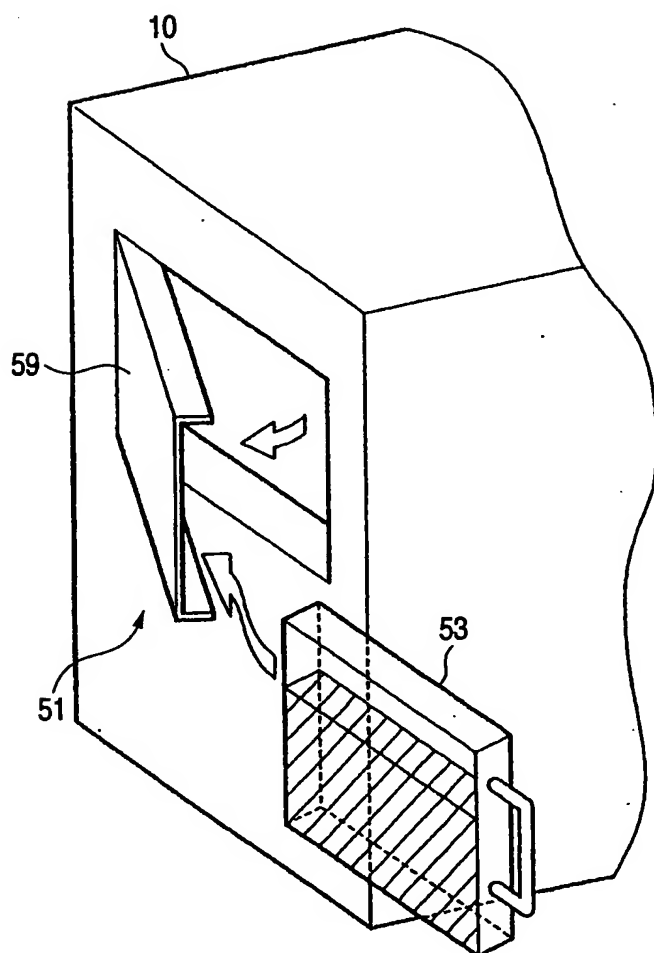


FIG. 23

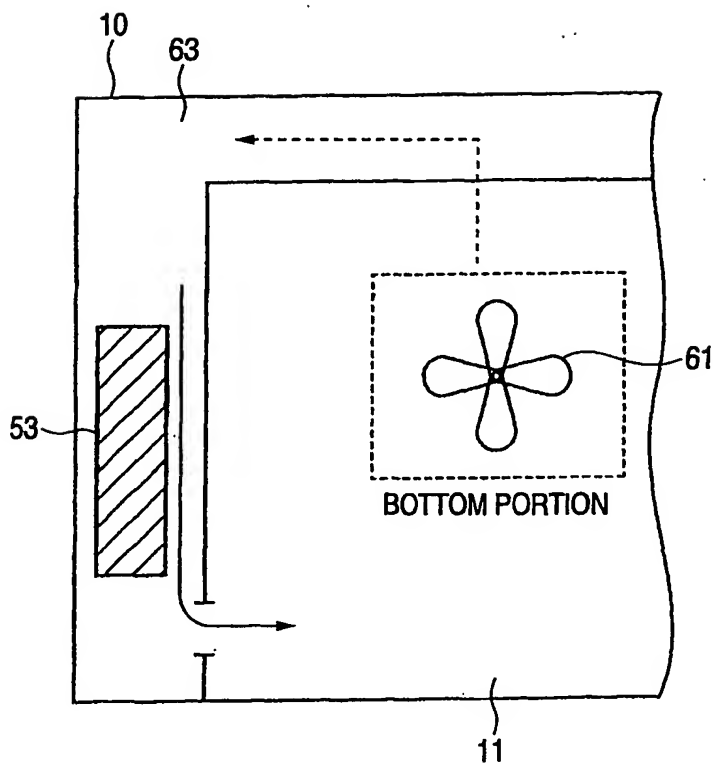


FIG. 24

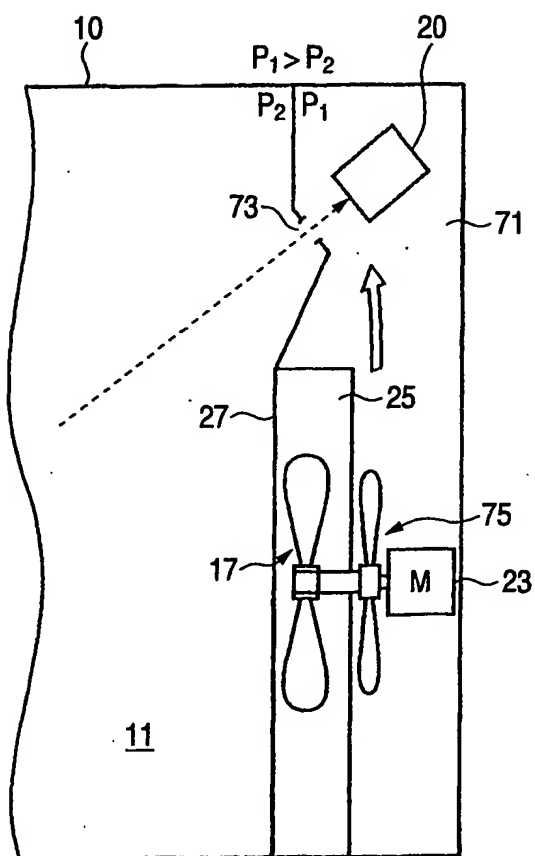


FIG. 25A

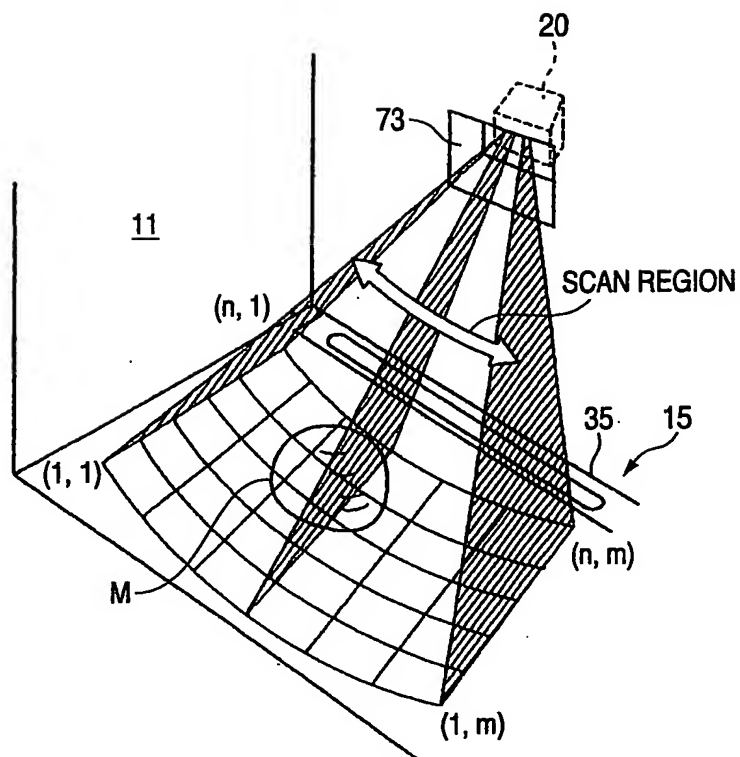


FIG. 25B

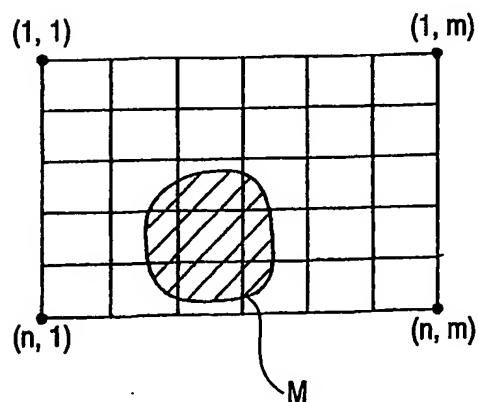


FIG. 26

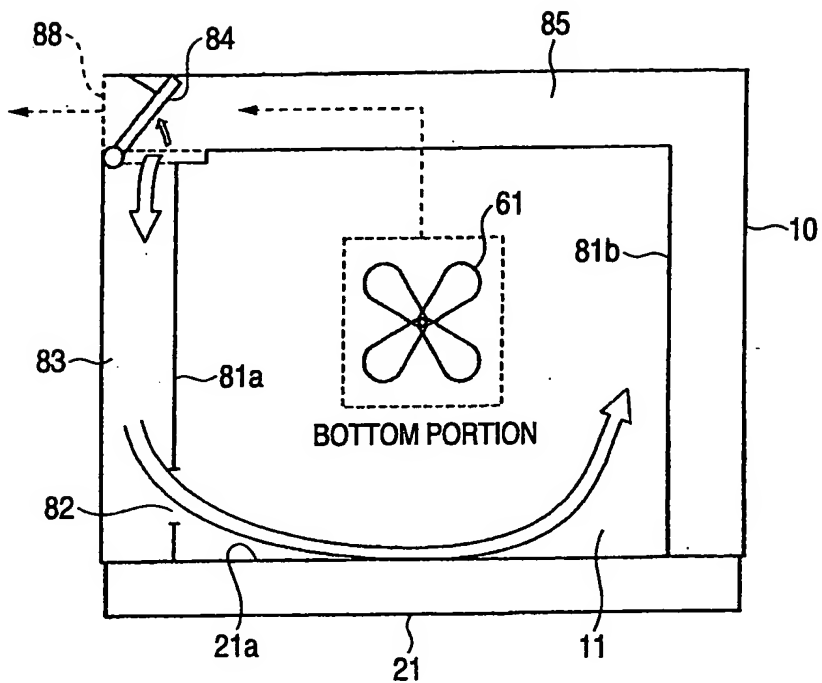


FIG. 27

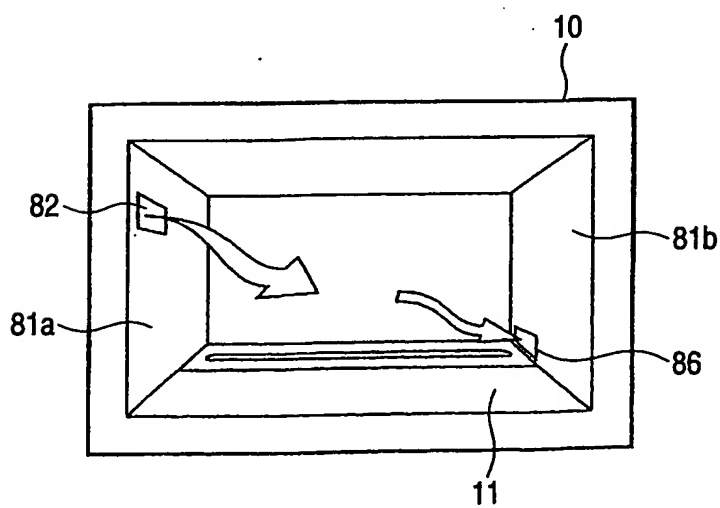


FIG. 28

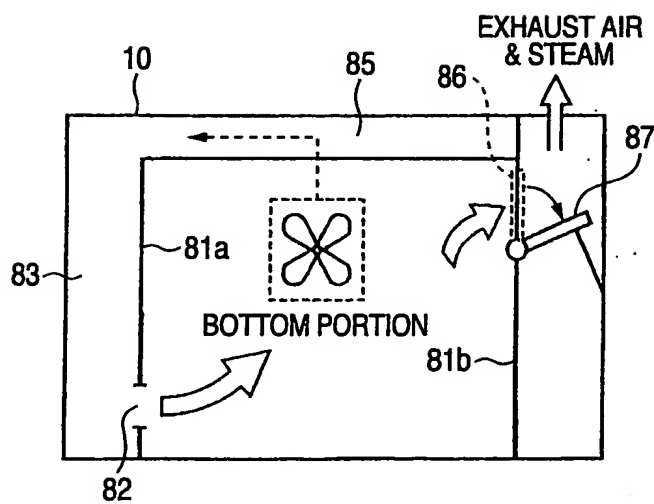


FIG. 29

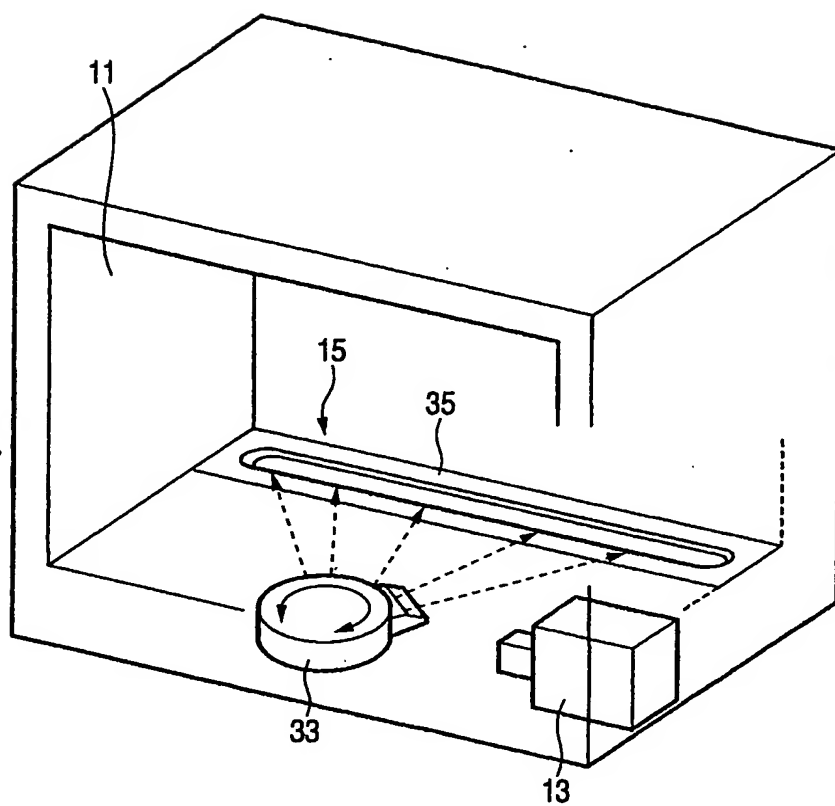




FIG. 30

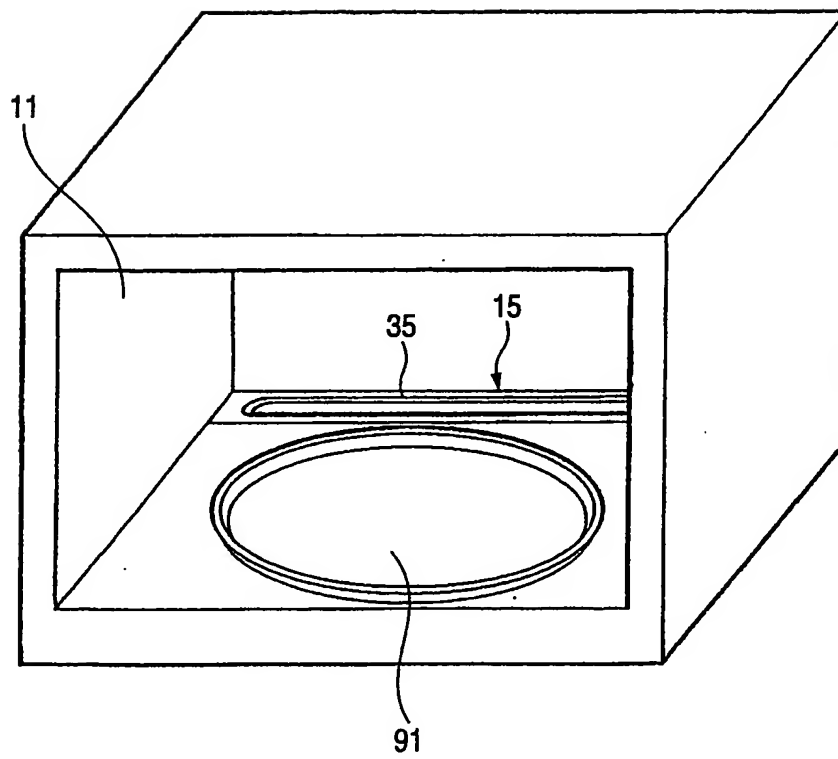


FIG. 31C

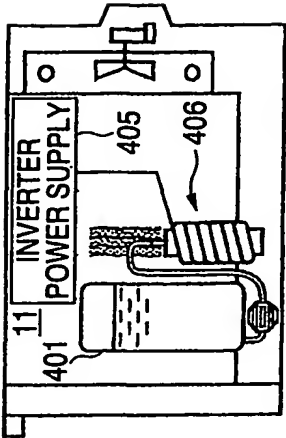


FIG. 31B

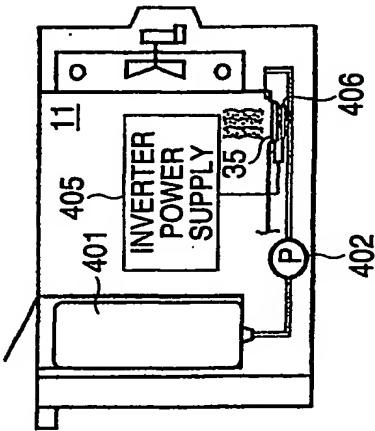


FIG. 31E

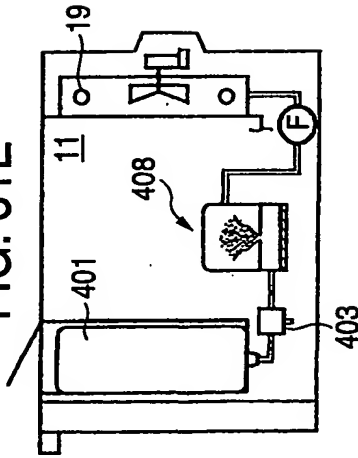


FIG. 31A

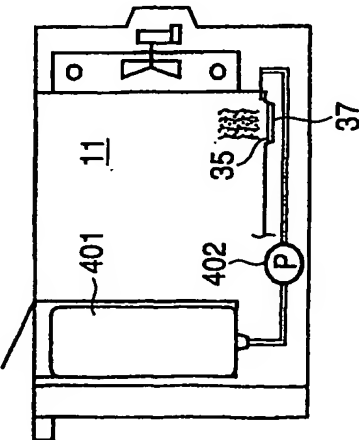


FIG. 31D

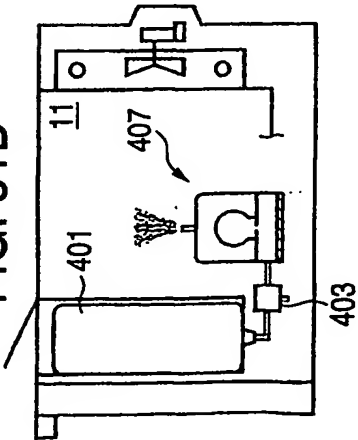


FIG. 32

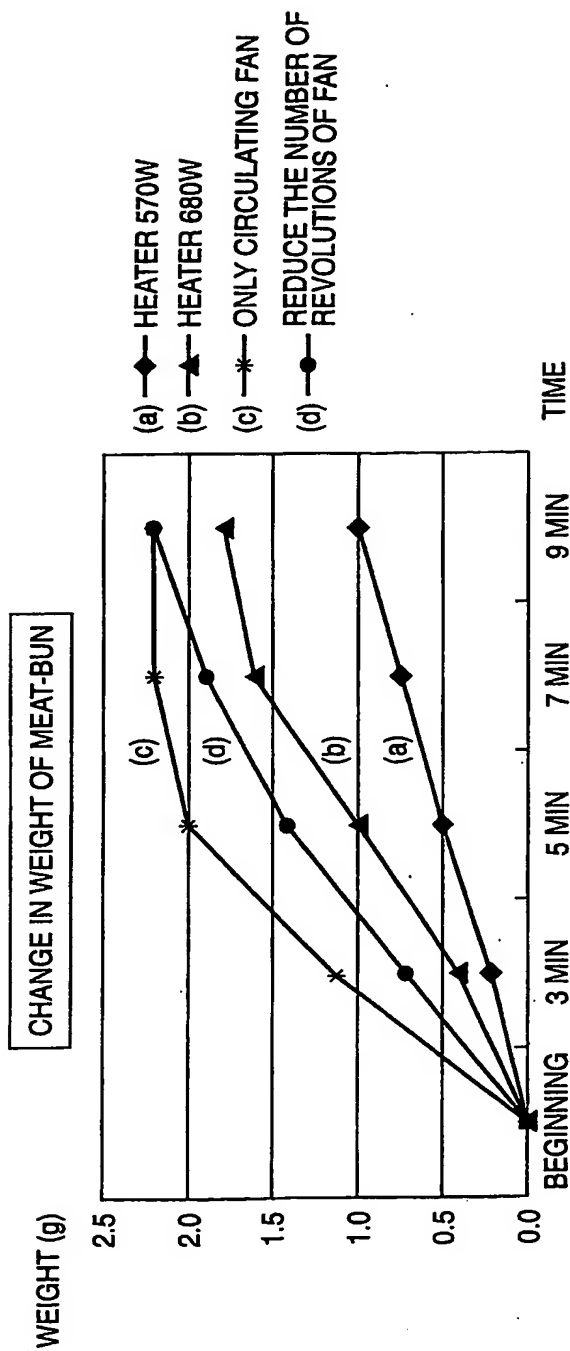


FIG. 33

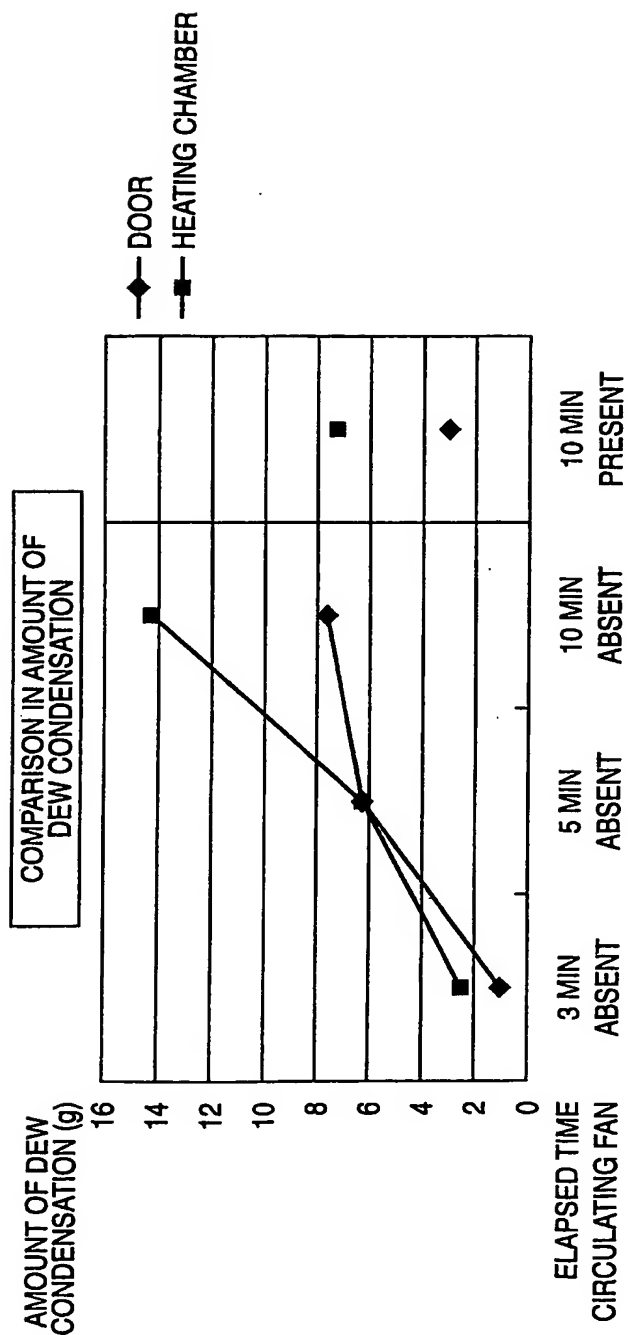


FIG. 34

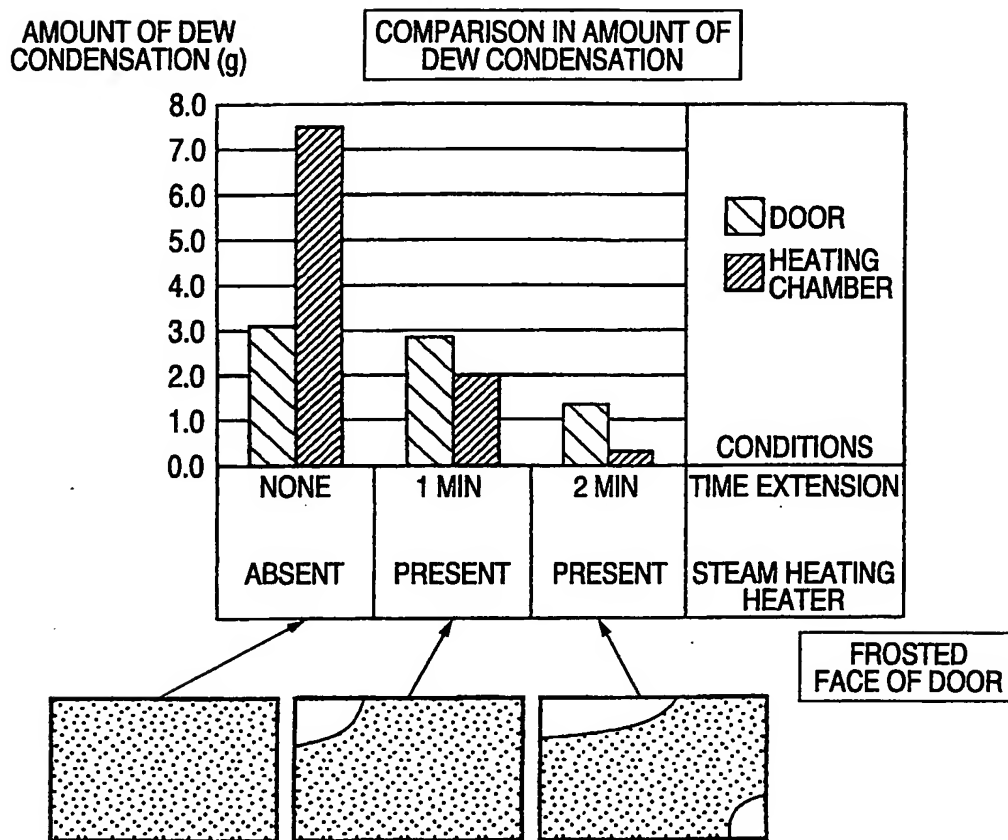
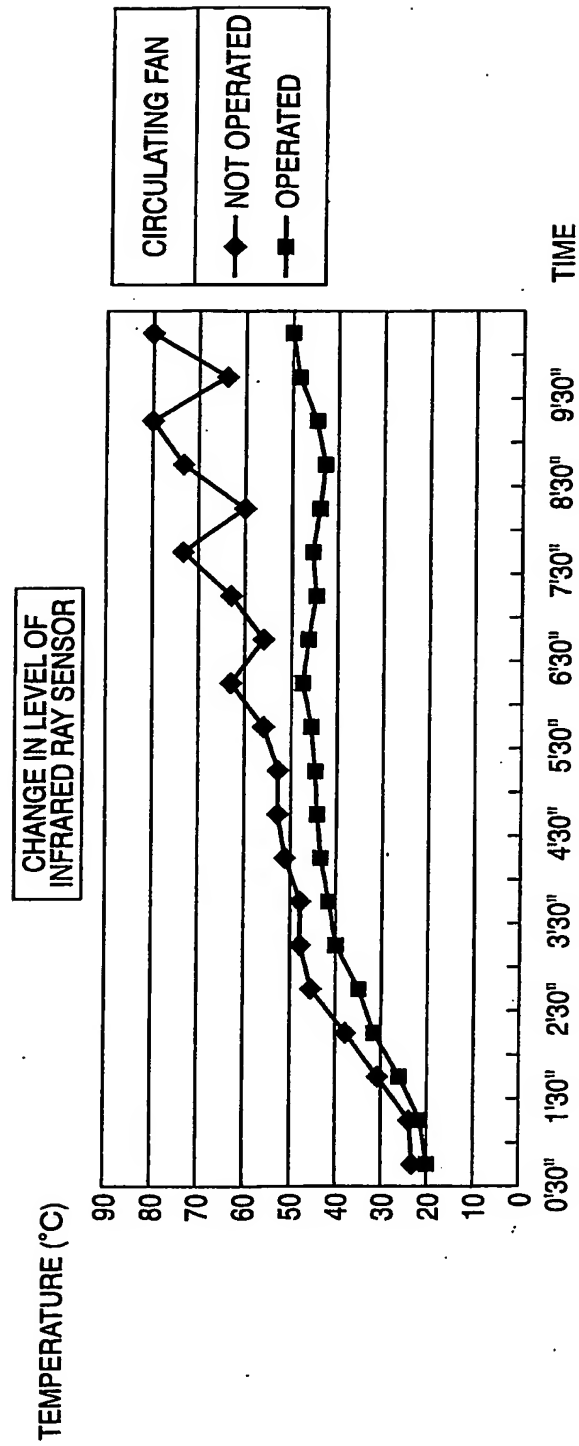


FIG. 35



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/JP 02/13843

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H05B6/80

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

PAJ, EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 018, no. 644 (M-1718), 7 December 1994 (1994-12-07) & JP 06 249445 A (SANYO ELECTRIC CO LTD), 6 September 1994 (1994-09-06) paragraphs '0009!', '0010!', '0025!', '0026!; figure 1	1-28
A	US 5 945 021 A (CHUNG JING-YAU) 31 August 1999 (1999-08-31) the whole document	1,4

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

3 June 2003

Date of mailing of the international search report

12/06/2003

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Taccoen, J-F

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/JP 02/13843

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
JP 06249445	A	06-09-1994	NONE	
US 5945021	A	31-08-1999	US 6104014 A	15-08-2000



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